Aviation Week

Including Space Technology

July 28, 1958

NATO Studies Northrop N-156 Design Concept

General Electric Plasma

Another application where dependability and efficiency count most . . .

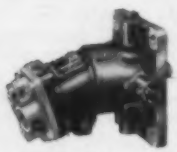
VICKERS® HYDRAULICS ON REPUBLIC F-105

Highest overall efficiency and minimum heat rejection of the pumps . . . and exceptional dependability of all components were decisive factors in the selection of Vickers Hydraulics for the powerful Republic F-105 Thunderchief.

The principal Vickers components in the F-105 are illustrated at the left. These, and all other Vickers aero hydraulic units and systems are tailored to airborne needs—light, compact, durable, dependable and efficient. Also, back of all Vickers products is a well organized and factory-staffed service organization.

For further information ask the district office in your area listed below for Bulletin A-5200-E.

Vickers 3000 psi Variable Displacement Piston Type Pumps supply power to the main control and utility hydraulic systems.



Vickers 3000 psi Constant Displacement Piston Type Pump operated by ram air turbine supplies emergency hydraulic power.

Vickers Constant Displacement Piston Type Hydraulic Motors perform critical functions requiring their high efficiency and distinctive control characteristics.

Vickers Flow Sensitive Pressure Regulator permits emergency ram air turbine to generate needed hydraulic flow down to minimum airspeed.

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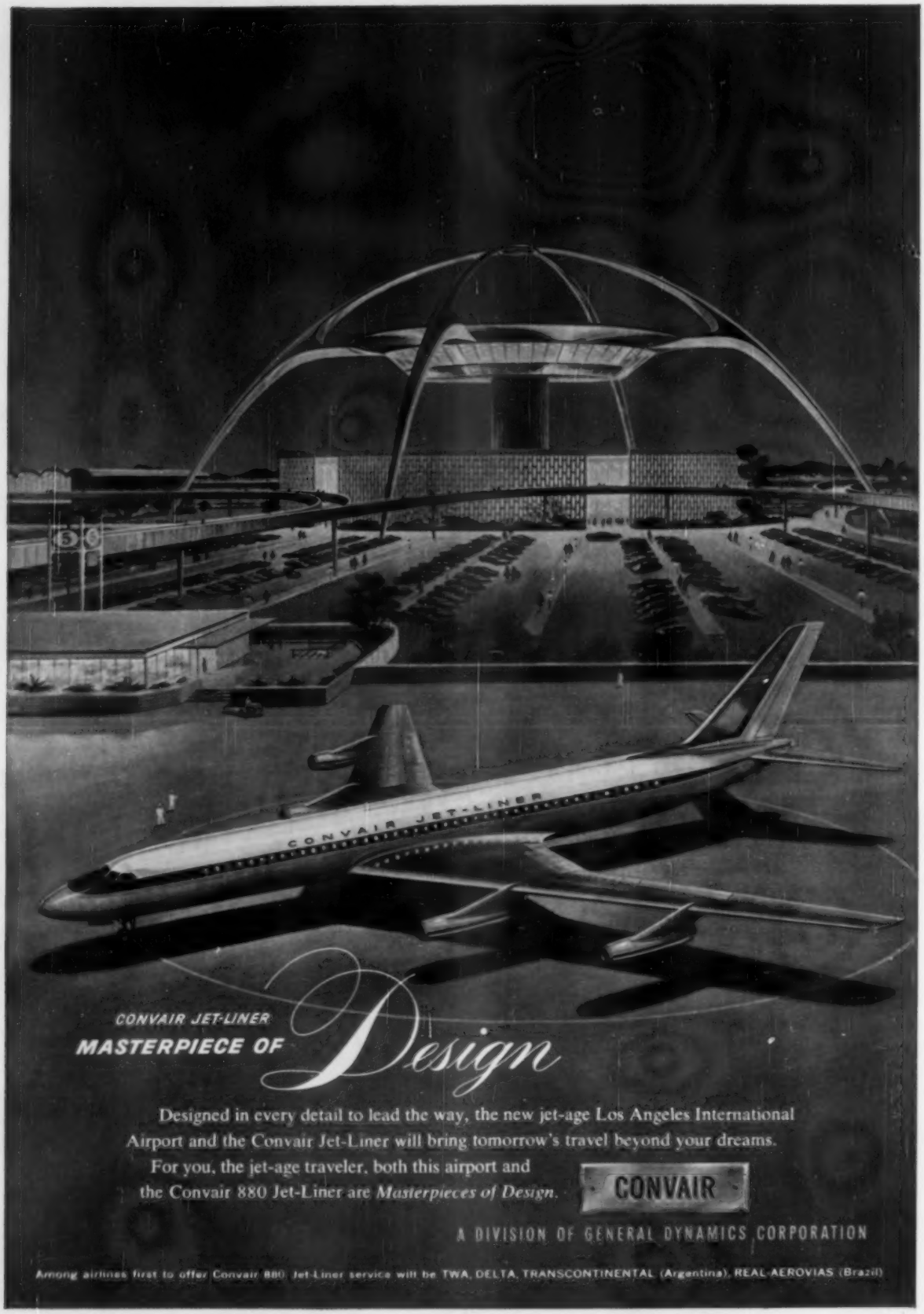
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



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A real "blessed event" is coming your way soon—the new Bendix AC-Pak*. And it'll be a knockout! It's fully regulated for voltage and frequency—and is built to give thousands of hours of efficient, trouble-free operation with minimum maintenance.

We have gone all-out in developing static inverters and we feel that we really have something to offer. *For example, our 1.5 KVA unit has been tested at 110°C and has produced a sine wave output without a trace of runaway.* Efficiency at this ambient was 83%, voltage regulation held at ±1% and frequency regulation ±.25%.

Right now it's still undergoing rigorous tests. When it proves itself completely, then, and only then, it will be ready for market.

You can count on the Bendix AC-Pak being released *soon*—but *not* before it is right for you. You'll find its extra dependability and high-level performance well worth the wait! Check the performance data below and you'll see what we mean.

*TRADEMARK, BENDIX AVIATION CORPORATION FOR DC TO AC STATIC INVERTER

INPUT

Voltage Range 25-30

Units capable of operating over an input voltage spread of 14-37 volts can be supplied at a weight penalty of 25%.

OUTPUT

Rating	Voltage	Phases	Eff. %	Approx. Wt. (Lbs.)
100 VA	115	1	78	4
250 VA	115/200	3	80	8
500 VA	115/200	3	82	12
1000 VA	115	1	83	16
1000 VA	115/200	3	83	19
3000 VA	115/200	3	85	32

Voltage Regulation ±1% **Frequency Regulation ±0.25%**
Total R. M. S. harmonic content under all conditions 2.5% max.
Overload capacity 200% of full load
Chassis temperature—continuous operation −50°C to +85°C

For short-life applications such as missiles, circuits are stable to 110°C chassis temperature.

West Coast Office: 117 E. Providencia, Burbank, Calif.
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Bendix
AVIATION CORPORATION

AVIATION CALENDAR

Aug. 5—Regional Technical Meeting on Space Exploration, sponsored by American Rocket Society and the Institute of the Aeronautical Sciences. For details: R. D. Linnell, General Chairman, Space Exploration Meeting, 3300 N. Harbor Drive, San Diego 1, Calif.

Aug. 6-8—Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, sponsored by the American Institute of Electrical Engineers, Hotel Statler, Los Angeles, Calif.

Aug. 7-8—Annual Conference, American Society for Quality Control, Western Region, El Cortez Hotel, San Diego, Calif.

Aug. 7-9—National Convention, OX5 Club of America, Hotel Statler, Los Angeles, Calif.

Aug. 7-15—Modern Developments in Heat Transfer, Continuation Course, University of Minnesota, Minneapolis, Minn.

Aug. 13-15—Conference on Electronic Standards and Measurements, National Bureau of Standards, Boulder Laboratories, Boulder, Colo. Sponsored by NBS, American Institute of Electrical Engineers and Institute of Radio Engineers.

Aug. 13-15—Seventh Annual Conference, Industrial Applications of X-ray Analysis, Albany Hotel, Denver, Colo.

Aug. 14-23—Ninth All-Women's International Air Race, Ontario, Canada to West End, Grand Bahamas.

Aug. 17-23—Missiles Operations Research, Engineering Seminar, Pennsylvania State University, University Park, Pa.

Aug. 18-19—Annual Western Regional Meeting, American Astronautical Society, Dinkelspeil Auditorium, Stanford University, Palo Alto, Calif.

Aug. 19-22—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

(Continued on page 6)

AVIATION WEEK Including Space Technology

July 28, 1958

Vol. 69, No. 4

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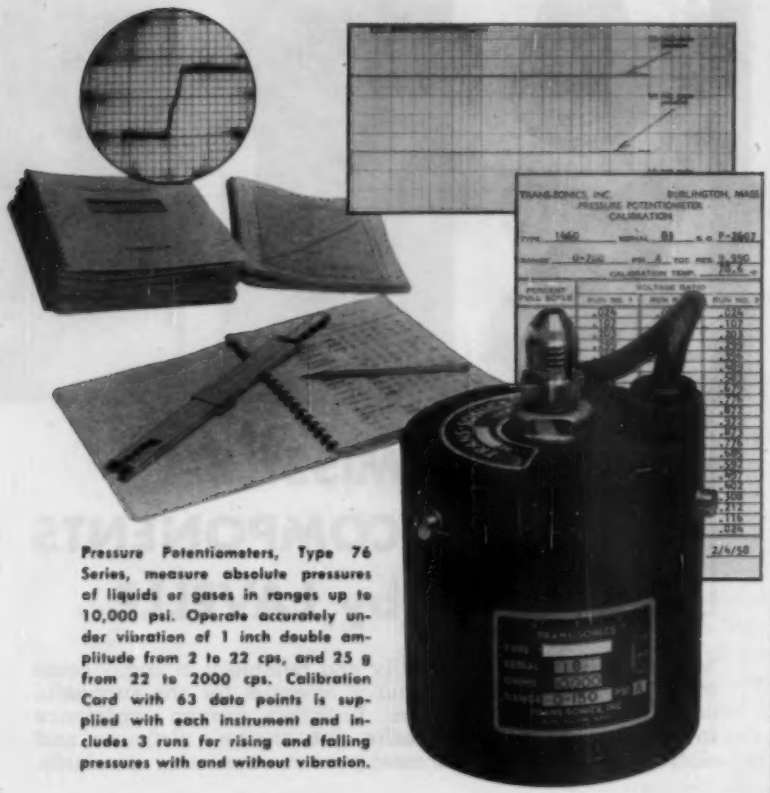

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TRANS-SONICS

Precision Transducers

AVIATION CALENDAR

(*Continued from page 5*)

Aug. 25-27—Third Annual Convention, National Flying Club Assn., Hollywood Roosevelt Hotel, Hollywood, Calif.

Aug. 25-29—Second Symposium on Naval Hydrodynamics, Washington, D. C.

Aug. 25-30—Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland.

Aug. 31-Sept. 1—Air Race, Professional Race Pilots Assn., Ft. Wayne, Ind. For details: Don Berliner, 19 Hudson Ave., Athens, Ohio.

Sept. 1-7—1958 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 2-12—Problems of High-Powered Radar Design, Summer Program, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required.)

Sept. 3-5—1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Sept. 9-11—Second National Conference on Applied Meteorology: Engineering, Ann Arbor, Mich. Program Chairman; Dr. D. J. Portman, 5500 East Engineering Bldg., University of Michigan, Ann Arbor, Mich.

Sept. 11-12—Annual Business Meeting and Conference, Northeast Chapter, American Assn. of Airport Executives, Municipal Airport, Worcester, Mass.

Sept. 15-18—Fall Meeting, American Rocket Society, Inc., Hotel Statler, Detroit.

Sept. 15-19—Annual Instrument-Automation Conference & Exhibit (International), Instrument Society of America, Philadelphia Convention Hall, Philadelphia, Pa.

Sept. 22-24—1958 Meeting Professional Group on Telemetry and Remote Control, Americana Hotel, Bal Harbor, Miami Beach, Fla.

Sept. 22-24—1958 Convention of the National Business Aircraft Assn., Bellevue Stratford Hotel, Philadelphia, Pa.

Sept. 25-27—Fifth Annual National Western Forum, American Helicopter Society, Ambassador Hotel, Los Angeles, Calif.

Sept. 25-28—Air Force Assn. Annual Convention and Airpower Panorama, Dallas.

Sept. 29-Oct. 3—National Aeronautical Meeting, Society of Automotive Engineers, Inc., the Ambassador, Los Angeles.

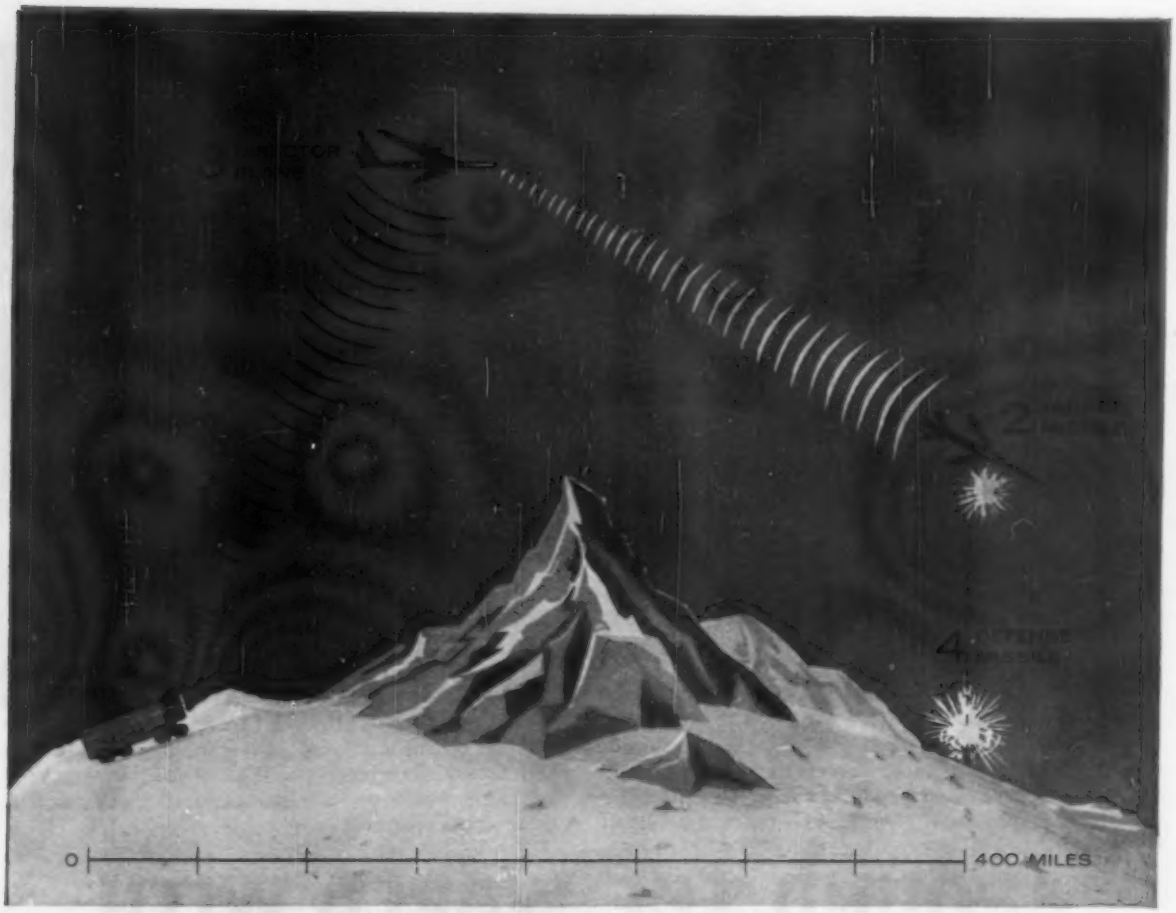
Sept. 29-Oct. 3—Semi-Annual Meeting and Western Tool Show, American Society of Tool Engineers, Shrine Exposition Hall, Los Angeles, Calif.

Oct. 1-3—National Airports Conference, University of Oklahoma, Norman, Okla. Co-sponsored by American Assn. of Airport Executives and the Civil Aeronautics Administration.

Oct. 7-8—1958 Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Chateau Laurier, Ottawa, Canada.

Oct. 22-24—Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif.

Oct. 27-28—East Coast Conference on Aeronautical & Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.



In action Sperry system, housed in air-transportable trailer (**1**), can command, track and telemeter drone flight data of supersonic target (**2**) either directly or through air director (**3**) when either long range or low altitude is involved. Object is to test readiness of anti-missile defense and accuracy of ground-to-air defense missile (**4**).

DRY RUN FOR USAF ANTI-MISSILE DEFENSE

New Sperry radar guidance system controls drones at 400-mile range

Accurate control of target drone in flight is maintained by operator at microphone through flight instruments on control console. Man in foreground monitors mission. Flight path of distant drone is traced automatically on plotting board at upper right.

A microwave command guidance system designed to help test U. S. defenses against potential enemy weapons has been successfully demonstrated to the Air Force.

Developed by Sperry under contract with the Air Research and Development Command, the system is scheduled for initial use with Q-4A supersonic drones. It is the first command guidance system to be considered for universal use to control other target drones, pilotless aircraft and missiles at high and low altitudes and at great distances.

The system tracks a vehicle, commands its engine and flight controls, and receives flight data—all on a single radar link. At extreme range or in mountainous terrain, the system operates through an air director. Like the master ground control station, this control aircraft is equipped with radar range, tracking, command, plotting and data receiving apparatus. In addition, chain-station operation capability enables long-range drones to be ground-controlled to maximum limits along the range.

This is the latest advance in Sperry's long history in the drone control field. Since 1946 Sperry drone control systems have been applied to many types of aircraft—both reciprocating and jet.

AERONAUTICAL EQUIPMENT DIVISION

SPERRY GYROSCOPE COMPANY
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TURBINE-POWERED SIKORSKY S-62—With an empty weight 700 pounds less than an S-55's and a turbine engine producing 200 more horsepower, the S-62 outperforms the earlier aircraft while offering the extra benefits of using proven S-55 components. A completely watertight boat hull provides takeoff and landing capability on water, land, and snow. The power plant is a G.E. T-58 gas turbine. The S-62, which will carry 12 passengers, has many advantages for both commercial and military operators.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

HELICOPTER "SKYHOOK"—The Army has found that disabled light aircraft can be successfully brought back to their home bases by helicopter. Above, an Army H-34 (Sikorsky S-58) from Fort Huachuca, Arizona, brings home an L-19 damaged in a landing accident at Tucson Municipal Airport, about 100 miles away.

ASSAULT AIRLIFT FOR 6000 MEN—Sikorsky helicopters flew 2000 sorties in a recent amphibious exercise on the Atlantic Coast. Flying from naval vessels, they carried ashore a Marine Corps regiment, 100 vehicles, and hundreds of tons of cargo. Hardest workers were HUS (S-58) and twin-engined HR2S (S-56) helicopters, above.

VERSATILE S-58 POURS CONCRETE—A Sikorsky S-58 moves into position before pouring a 2700-pound load of ready-mixed concrete from its hopper. Helping to build a high-voltage transmission line in California, the S-58 airlifted working crews, as well as batches of concrete for the tower footings, and finally carried sectionalized steel towers to the inaccessible sites. The S-58 eliminated the need for a costly construction road, and saved time. S-58s have proved their rugged dependability in a variety of construction jobs, as well as in passenger and cargo transportation. Sikorskys are the only large helicopters fully proved in commercial service.

SIKORSKY AIRCRAFT
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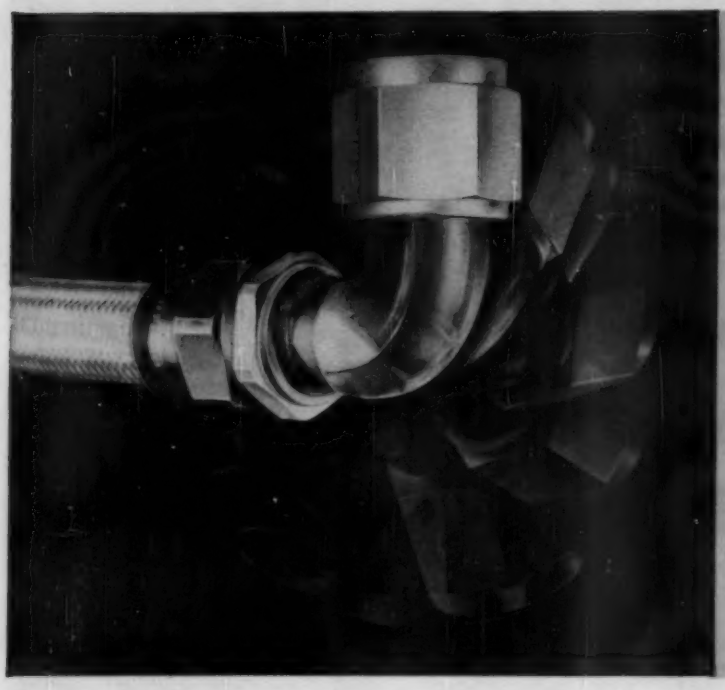
...THE TRULY REUSABLE FITTING FOR FLUOROFLEX®-T HOSE



adjusts 360° with no loss of grip

BASIC GRIP NEVER LOOSENS

Socket and unique lockring in SEAL-LOCK fitting exert unshakable grip on hose. Once applied, this hold need never be disturbed when adjusting elbows. Lockring keeps initial grip strength no matter how much or how often elbow is swiveled... *an exclusive* SEAL-LOCK *safety feature*... extra blow-off insurance.

STAYS LOCKED AND LEAKPROOF

When tightened, SEAL-LOCK fittings are triple-locked and dynamically sealed. Left hand safety thread cannot accidentally loosen during installation of hose assembly. Lock nut effect prevents loosening by vibration during operation.

COMPLEMENTS INTEGRITY OF FLUOROFLEX-T HOSE

Fluoroflex-T is a chemically inert compound of Teflon® developed and patented by Resistoflex. It assures completely reliable performance in aircraft and missile systems... for protection of equipment and human life.

PARTS INTERCHANGEABLE — TRULY REUSABLE

Ideal for mock-up work. Substitute an elbow for a straight nipple or vice versa. Permits quick repair of damaged nipples. No need to change hoses or touch socket to change couplings. Parts are hardened . . . can be reused again and again. Send for Bulletin RF-1.

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® Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
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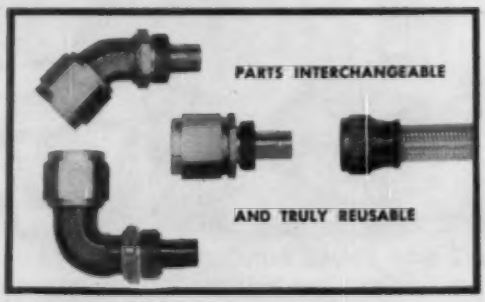

Originators of high temperature fluorocarbon hose assemblies

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Roseland, New Jersey • Western Plant: Burbank, Calif. • Southwestern Plant: Dallas, Tex.

July 28, 1958

Aviation Week
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COVER: Hot plasma jet from General Electric Co.'s large, new air arc (AW July 14, p. 71) goes through a test run. Uppermost pipe clamped to angle iron is water cooled model support. In operation, specimen would be attached to end of a "sting" extending at right angles from support bar down into jet. Lower pipe ending in middle of flame is a graphite probe used to measure electrical field. Although precise measurement is almost impossible, temperatures created by the arc are believed to run as high as 26,000F and are used to test materials and shapes for possible re-entry applications.

PICTURE CREDITS:
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New B. F. Goodrich Liquid-Cooled Brake solves aviation's hot landing problem

HERE'S a revolutionary new braking system developed by B. F. Goodrich that absorbs millions of foot-pounds of energy—yet stays cool enough to touch. This is the first and only proved Liquid-Cooled braking system designed specifically to handle the higher energy conditions of jet aircraft today and in the future.

In the B. F. Goodrich Liquid-Cooled Brake, a coolant fluid circulates behind the friction surfaces, absorbs heat and carries it to a heat exchanger where it is safely dissipated at low temperatures. Excessive heat build-up within the wheel and brake area is eliminated. Friction surfaces maintain their normal stopping characteristics at all times.

During recent flight tests on the Boeing 707 prototype, including repeated taxi tests and power drag, the B.F.Goodrich Liquid-Cooled Brake operated consistently at maximum temperatures well below 500° F—compared with 1500-2000° F for conventional brakes. No cool-off periods were necessary. Even after a stop where maximum braking was applied for highest rate of deceleration, crew members were able to rest their hands on the brakes without discomfort. The brakes were exceptionally smooth and positive—no fade, no noise, chatter or sparks.

B. F. Goodrich engineers are ready to work with you in designing the new Liquid-Cooled Brake system into your high-performance aircraft—without a weight penalty. Write B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Troy, Ohio.

B.F.Goodrich aviation products

EDITORIAL

Von Karman on Space

(No scientist in the free world enjoys a more solid reputation for his achievements in aerodynamics and rocket propulsion than Dr. Theodore von Karman. Nor is any scientist known for a more adventuresome spirit in constantly probing the unknown and extending the frontiers of basic knowledge in his chosen fields. Because of the eminence of Dr. von Karman, Aviation Week *is presenting in full his views on the role of the aviation industry in space exploration as written for "Planes," the official publication of the Aircraft Industries Assn. —***Robert Hotz,** *editor.)*

It is natural that spectacular, new scientific ventures should catch the public eye, particularly in the present impetus to "inaugurate the space age."

But the success of a few worthy projects in space technology has resulted in some extraordinary conclusions by a number of serious people including scientists, engineers and industrialists.

They seem to believe that most problems in the domain of so-called conventional aircraft or jet engines, which we considered quite important a year ago, are no longer significant.

Extension of Our Activities

There are few voices that have the courage to point out that the new age of space science and technology is essentially an extension of our activities in the same direction that science and technology followed in the last half century.

We like to talk of certain "barriers" to flight. The first was the sound barrier, although there never was a convincing reason why an aircraft should not fly faster than sound; ballisticians took for granted 200 years ago that projectiles accelerated in a gun barrel would fly with supersonic speeds. Science trailed along behind, in that the ballisticians took the empirical point of view while theoretical aerodynamicists first achieved an understanding of the laws of supersonic flight in the early thirties. To be sure, the theory of supersonic flow in nozzles was considerably older.

Two more barriers were supposed to limit speed and altitude; the new barrier to speed was called the "heat barrier," due to the high temperatures developed by air friction at very high flying speeds; the barrier of altitude seemed to be given by the limits of functioning of air-breathing engines.

Space flight is not limited by either of these barriers. The heat barrier may cause serious difficulties when we want to re-enter the dense atmosphere of our own planet or enter the environments of other planets, moons or stars.

However, this is a transient process, whose duration can be limited, and many solutions are already promised. The altitude problem requires several developments: stretching of the possibilities of air-breathing engines to higher Mach numbers and lower densities than are accepted nowadays, more scientific developments of rockets and "unconventional" propulsion methods like plasma jets, the exploitation of secondary power sources such as solar energy and electric and electromagnetic fields for particle acceleration.

I do not see any point in these developments which would indicate that:

A. Our aeronautical research institutions, such as the National Advisory Committee for Aeronautics, the university and industrial research laboratories cannot do the basic and exploratory research and the collection of theories and facts, as they did with such evident success in the domain of flight within the atmosphere;

B. The military services should not consider the new activities as a natural extension of their missions and carry out the operations within the framework of their command system;

C. The aeronautical industry should not undertake the design of prototypes and production of standardized items on the same basis as they developed radically new types within the limits of atmospheric flight. I am also convinced that the solution of the new problems will be greatly facilitated by use of the experienced staffs of the companies now engaged in aircraft and engine design and production.

It is, I believe, a natural conclusion that the best way of administering space projects would be the utilization of an agency like the National Advisory Committee for Aeronautics, which presently combines long experience in administration with far-reaching vision for future developments.

Of course, we aeronautical engineers have to broaden our views and fields of investigation. In addition to thermodynamics, which has always been involved in the problems of high-speed flight and engine design, we have already combined aerodynamics with chemistry for the solution of combustion problems especially in jet engines and rockets.

'Aerothermochemistry'

I suggested the term "aerothermochemistry" for this branch of the aeronautical sciences, and "aerothermochemistry" has become more and more important because of the chemical changes—dissociation and recombination—occurring in flight at the frontiers of the atmosphere. Finally, we have to renew and expand our high school knowledge of astronomy, and perhaps devote time and thought to a new branch of fluid dynamics: "magnetoaerodynamics."

However, those who would say that all that we teach and all that we investigate under the name aeronautical engineering is obsolete seem to assume that by some miracle the designers of space vehicles will not encounter problems involving such classical sciences as fluid mechanics, structure, materials and vibrations. I am sure that this will not be the case.

—Theodore von Karman

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WHO'S WHERE

In the Front Office

Brig. Gen. Albert H. Schwichtenberg, retiring Command Surgeon of Air Defense Command, to head new department of Aviation and Space Medicine, Lovelace Foundation for Medical Education and Research, Albuquerque, N. M.

F. T. Hinkley, A. A. Lombard, J. L. E. Smith, board of directors, Rolls-Royce Ltd., England.

Bernhardt L. Dorman, vice president-test engineering; **Richard D. Geckler**, vice president-solid rocket plant; **William L. Gore**, vice president-customer relations; **William L. Rogers**, vice president-Azusa operations; **John S. Warfel**, vice president-avionics; Aerojet-General Corp., Azusa, Calif.

Honors and Elections

Air Force Exceptional Civilian Service Award has been presented to **Karel J. Bossart**, technical director of Convair-Astronautics, for ". . . leading role in development of the Atlas intercontinental ballistic missile."

First Annual Borg-Warner Trophy for achievement in advancing technology of missiles and astronautics has been awarded to Lockheed Aircraft Corp., Sunnyvale, Calif.

Council of the Society of British Aircraft Constructors has elected **A. F. Burke**, managing director of the de Havilland Aircraft Co., Ltd., president of the Society, and **Sir George Dowty**, vice president.

Changes

Capt. George B. Chafee, USN, chief, Plans Office, Airways Modernization Board, Washington, D. C.

Frederick W. Gill, vice president, Aviation Division, United States Leasing Corp., San Francisco, Calif.

Edward R. Nauman, general manager, Longhorn Division, Thiokol Chemical Corp., Marshall, Tex.

Robert E. Dake, retiring chief of General Safety Division, Civil Aeronautics Administration, Los Angeles, Calif.

Eugene Parks, sales manager, Electro Tec Corp., So. Hackensack, N. J.

Frank A. Flower, manager Washington office, Thompson Products, Inc., Cleveland, Ohio.

Col. C. V. (Bud) Burnett, retiring as director, Detroit Aviation Commission and manager of Detroit City Airport, Detroit, Mich.

Edward M. Lisowski, Dayton, Ohio sales representative, General Precision Laboratory, Inc., Pleasantville, N. Y.

Robert W. Bowman, vice president in charge of organization planning, Aeroquip Corp., Jackson, Mich.

George W. McLellan, coordinator of technical information, Division of Public Affairs, Corning Glass Works, Corning, N. Y.

William Q. Nicholson, associate technical director and manager of engineering plans and programs, BJ Electronics, Borg-Warner Corp., Santa Ana, Calif.

INDUSTRY OBSERVER

► Pistol-grip, stick-type sidearm control system of the kind to be used in the X-15 rocket research plane is being evaluated on a North American F-107A at National Advisory Committee for Aeronautics' High Speed Flight Station, Edwards AFB, Calif. Pitch-control axis is through pilot's wrist, roll-control axis is below pilot's wrist. System, unlike one earlier sidearm control tested on other NACA planes, is hydraulically boosted. Center sticks cannot be controlled under high accelerations, decelerations expected in X-15.

► Reaction jet controls being tested on the Bell X-1B rocket plane are simple on-and-off controls, do not have variable thrust as will the system to be used later on North American's X-15 rocket plane. X-1B has jet port only on one wing; pitch and yaw jets are at aft end of fuselage. X-15 has ports on each wing, and pitch and yaw jets are in the nose.

► Thompson Products-Ramo-Wooldridge Corp. has begun experiments with small monopropellant orientation rockets for satellites, spacecraft and ballistic missiles. Hydrazine is used as monopropellant in some experiments. Company also is studying reliable rocket ignition techniques in which a small, easily handled plastic bag of red fuming nitric acid is loaded into a cylinder behind the injector face. Piston mashes bag against a spoke and pumps red fuming nitric acid into chamber to initiate combustion in fuels forming hypergolic combinations.

► Rene 41 is a special alloy developed by General Electric Co. for very high temperature gas turbine service. Material probably is planned for future turbojet designs.

► Nortronics Division of Northrop Aircraft Inc. has designed a highly sensitive angle of attack sensor for North American Aviation's X-15 high altitude rocket research plane. Sensor is based upon simple electric pressure transducers and is essentially needed to ensure precise re-entry altitude control.

► NACA's five-stage research rocket, which reaches velocities of Mach 16 and above, was preceded by Mach 10 four-stage rockets, Mach 7 three-stagers, Mach 5 two-stagers and Mach 3 single stage vehicle. Firings are from Pilotless Aircraft Research Station, Wallops Island, Va.

► All-flying vertical stabilizer on F-107A is limited to throw of three degrees either side of neutral for a wheels-up condition, six degrees for wheels down. Because entire large slab is movable, less flow is required in comparison to relatively small rudder tabs that are attached to fixed stabilizers on other aircraft.

► Informed sources in Europe say contracts for Fiat's G.91 lightweight strike fighters are still unsigned even though France, Italy and Germany want some aircraft for operational use. Germans want pooled order to take advantage of reduced price in quantity, but the interested French parties reportedly are delaying their order to pressure the Germans to buy Dassault Mirage 3 interceptors.

► North American's four-passenger Sabreliner UTX jet transport is scheduled to receive 2,000 lb. thrust General Electric J85 engines before Aug. 1. First flight with two J85s now is scheduled for Aug. 29.

► Last two firings of Douglas Thor intermediate range ballistic missile incorporated operational versions of the weapon. Present program is to prove the missile's reliability, gain experience for launching crews. Thor has not yet been fired by a full Air Force crew.

► Avro Blue Steel air-to-surface missile, which has been shown on Avro's Vulcan bomber, will be carried completely inside the weapons bay of the Handley-Page Victor. Vulcan installation mounts the missile partially outside the bomb bay.

Washington Roundup

New ARPA Miff

Defense Department's Advanced Research Projects Agency, jealous of its prerogatives and miffed once again at the Air Force, has dispatched a six-page teletype communication to military installations specifying that no information on missile contracts under its cognizance is to be released unless it is released by ARPA. Air Force's newest visit into the ARPA doghouse was prompted by its release of information concerning planned contracts for the Minuteman intercontinental ballistic missile (see page 27).

Earlier miff stemmed from a statement by Lt. Gen. Samuel E. Anderson, head of the Air Research and Development Command, concerning the tentative launching dates for USAF's lunar probes, which are under ARPA cognizance (AW June 16, p. 292). At that time, ARPA forced Air Force Secretary James H. Douglas to publicly reprimand Anderson and to declare that his "so-called planning dates" should be "wholly disregarded" —this despite the fact that the general's dates were eminently correct.

Abolish Patents?

A report by a Senate Judiciary Subcommittee favors doing away with patents as a system of "a bygone era" which no longer achieves its purpose of "promoting science and the useful arts." In universities and non-profit institutions, it declares, "The effect of patenting pressures has been to interpose managerial controls and commercial pressures where free, uninhibited inquiry is needed to promote the flow of science."

It maintains that industrial firms, on the other hand, "will continue to operate and expand their research facilities in order to serve their particular competitive requirements, whether a patent system exists or not. These units, and others, will continue to rely primarily on the non-profit research institutions for expansion of the underlying body of science from which technological application is nourished."

Chains of Command

Many have criticized "the long chain between the people who are enthusiastically for (space flight) projects and the people on top who finally approve them," but Dr. Fred Singer of Maryland University has given members of the Joint Atomic Energy Committee a specific case (see page 26). "The Far Side project for a 4,000 mi. rocket, which I am associated with, is a good example," Singer testified. "The design was completed three years ago. It took two and a half years to move it to the top.

The actual doing of it, once the contract was let, took less than six months."

New Space Committee

House last week approved formation of a new Standing Committee on Science and Astronautics to take over the duties of the Select Committee on Astronautics and Space Exploration. The new committee will be composed of 25 members and will have jurisdiction over all matters relating to science and space exploration. In addition to the new National Aeronautics and Space Administration, the Committee will have jurisdiction over the Bureau of Standards and National Science Foundation, now under the Interstate and Foreign Commerce and Armed Services Committees. Senate is expected to create a similar committee of 15 members.

NACA Budget Cut

House-Senate conferees last week cut National Advistory Committee for Aeronautics' budget for Fiscal 1959 by $5.2 million "taking cognizance of the fact that the new space agency recently created by the Congress will absorb the NACA and will require additional funds." The Senate previously voted NACA $106.3 million, the full amount requested.

The House voted $101.1 million, the amount accepted by the joint conferees.

Defense Reorganization

Heated controversy between the President and Congress over reorganization of Defense Department apparently came to an end last week and conferees of House and Senate approved legislation in a brief 20 minute session after the Senate by a unanimous 80-0 vote approved a version generally in line with the version passed by the House.

The congressional legislation includes provisions in modified form which the President had vigorously protested (AW June 9, p. 17). These provide for separate organization of the three military departments, for congressional authority over changes in combatant functions of the services by the Secretary of Defense and for the right of the military chiefs of staff to appeal to Congress.

Sen. Stuart Symington (D.-Mo.), who has been in full accord with the President's plan voted for the measure, but said he doesn't think it "goes far enough from the standpoint of basing our Department of Defense on progress rather than continuing to base it on tradition."

Federal Aviation Hearings

Hearings on a bill establishing the proposed Federal Aviation Agency were resumed last week by a House subcommittee after being side-tracked in favor of the more spectacular probe of the relationship between presidential aide Sherman Adams and Boston textile manufacturer Bernard Goldfine. Although the subcommittee was scheduled to conclude hearings after listening to Slick Airways President D. W. Rentzel last week, aviation officials are showing increasing concern that the bill may reach the House floor too late for action this session. In such an event, it would be necessary to introduce new bills in both Houses of Congress next year which could postpone the creation of the independent agency until 1960.

The Senate already has passed the bill (AW July 21, p. 31). One spokesman for the subcommittee suggested that it would be another two weeks before the bill is reported out by the House Commerce Committee and sent to the House for a vote.

If Congress adjourns by the middle of August, an unofficial target date, the Federal Aviation Bill could possibly get lost in the final scramble to push through last-minute legislation.

—Washington staff

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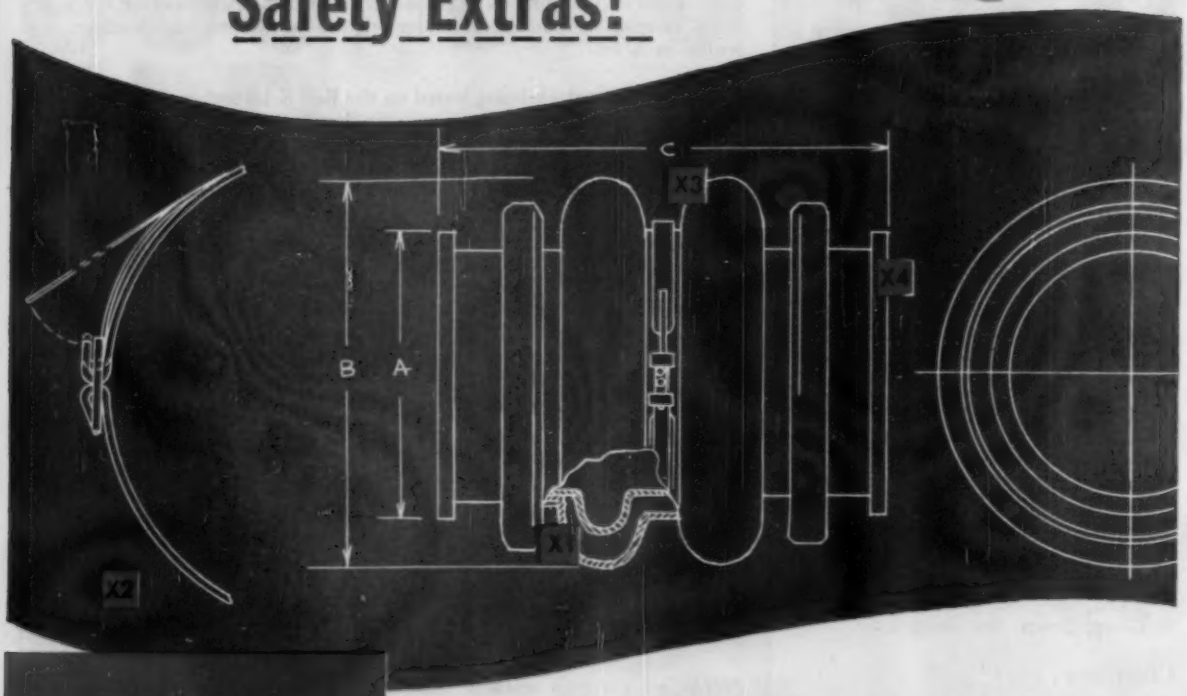

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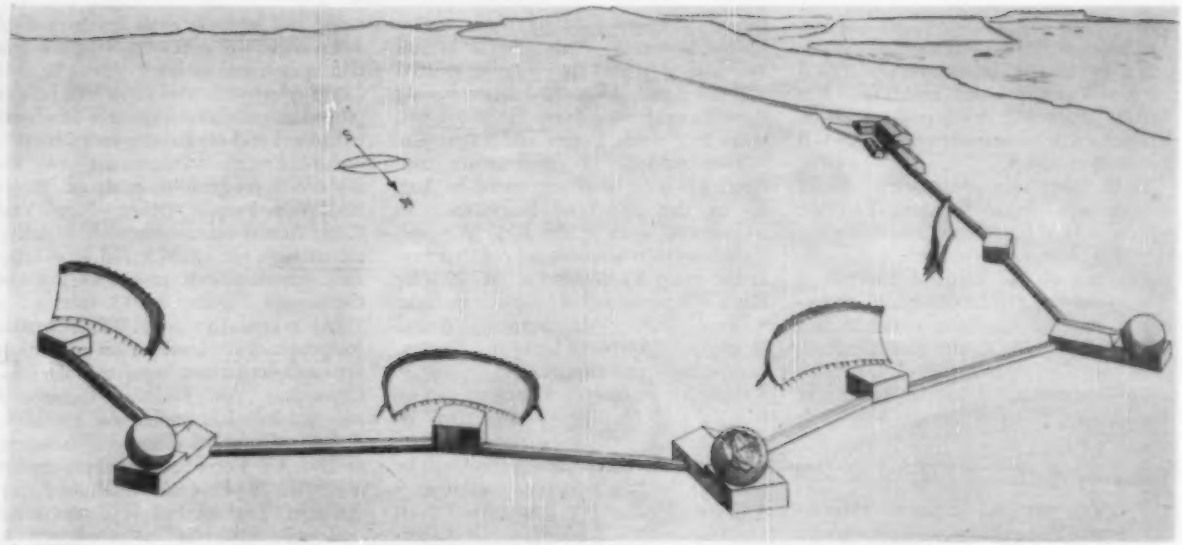


SITE DETAILS of USAF's Ballistic Missile Early Warning System installation at Thule, Greenland, are shown in the artist's sketch above. Three large buildings are radar transmitter buildings with tracking radars mounted in radomes on the roofs. Computers will be installed in center transmitter building. Four smaller buildings house organ-pipe scanners for detection radars. Airbase is behind the hill in the background but Thule landmark, Mount Dundas, appears at upper right.

Army Reveals BMEWS Radar Site Details

By James A. Fusca

New York—USAF's Ballistic Missile Early Warning System will employ four large detection radars and three tracking radars at each of the two sites presently selected. Installations will be at Thule, Greenland, and Fairbanks, Alaska.

No decision has been made on the necessity of a third site, originally planned for Iceland or Prestwick, Scotland. If the system's radars meet performance expectations, a third site may not be required and the political problems posed by the choice of either location may be avoided.

Contracts have been let and construction of foundations and access roads begun at Thule to take advantage of the area's short June-through-September construction period. First contracts for the Alaska installation are expected to be awarded in about six months.

BMEWS Operation

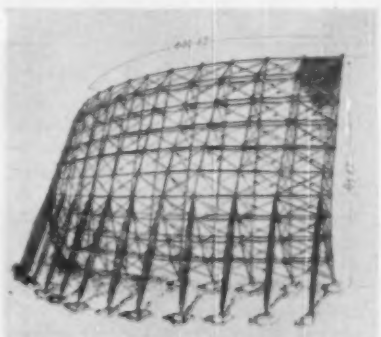
Purpose of the four 3,000 mi. range detection radars to be installed at each site is to scan a fixed azimuth sector of the air space over the Soviet Union to detect intercontinental ballistic missiles as their trajectory brings them above the radar horizon. Each radar will sweep an azimuth sector of about 30 deg. to obtain a total azimuth coverage at each site of approximately 120 deg.

These detection radars will employ split beams, vertically offset by a few degrees, which will be swept back and forth horizontally at high speed by means of an organ-pipe antenna scanning system. From azimuth angle of interception of a detected missile, angular difference between beam interceptions and time of travel, a computer will make a rough determination of the incoming missile's trajectory to aid acquisition by a tracking radar (AW Feb. 24, p. 66).

Twofold purpose of the three tracking radars at each site will be:

- **Identification.** Tracking radars must attempt to identify a detected object as a missile rather than a meteorite or falling satellite.
- **Impact point.** Radars also will provide data for computing point of launch and point of impact.

Complex scanning system to be used with the large parabolas of the tracking radars will provide an additional capability as a detection radar so that a tracking radar may be used to scan the sector of a detection radar that is out of service. Range of the tracking radars also will be about 3,000 mi.



TRUNCATED parabolic reflectors for radars measure 400 ft. long by 165 ft. high.

Both types of radar will produce peak powers larger by an order of magnitude than any radar in existence today; average powers will be in the neighborhood of one megawatt. Detection radars will operate in the UHF region while tracking radars will employ extremely wide band operation, extending from VHF to S-band.

Cost Rise

Total cost of the BMEWS installations was first estimated to be approximately $720 million. This figure, however, has grown with age and present estimates run as high as $720 million per site. Radio Corp. of America holds the prime contract from the Air Force for this work. Western Electric Co. has been awarded a second contract covering the forward scatter communications system to connect the sites with the U. S.

First details of the BMEWS site for Thule, Greenland, which are nearly identical with the Fairbanks, Alaska, site, have been disclosed by the Eastern Ocean District of the Army Corps of Engineers, construction agency for the Air Force.

Each site of the system will be made up of seven radar buildings laid out in a semi-circle about a mile long and connected by a weatherproof passageway large enough to accommodate maintenance vehicles.

The four detection radars will employ fixed truncated parabolic reflectors measuring about 165 ft. high and 400

U.S. Bypassed on ASW Plane for NATO

Requirements were withheld by committee for months; Navy fails in bid to keep competition open.

By David A. Anderton

Geneva—NATO's anti-submarine warfare aircraft competition which closed June 21 is well on its way to being a political hot potato.

Conceived in committee and concealed from all but a selected handful of European aircraft manufacturers, the requirements for the ASW design were finally circulated to ten American firms after loud protests from qualified contractors and the U.S. Navy's Bureau of Aeronautics.

Cognizance of the project for American companies is reportedly under an ex-ASW pilot in the U.S. Navy's Office of Naval Material.

Over-all direction of the project remains with a special committee headed by an Englishman, Henry C. Bloss, head of the Aircraft Section, Production and Logistics Division of the NATO Secretariat.

One American bid to beat the closing deadline was a proposal by the Martin Company to act as weapons system manager.

Navy's Bureau of Aeronautics, responding to pleas by some of its contractors, tried to keep the competition open for an additional 30 days to give an equal chance to American design teams, but was unsuccessful.

Many technicians familiar with the manifold problems of anti-submarine warfare doubt that there was sufficient time allotted to the competition anyway. One pointed out that the task demands the most sophisticated weaponry available or imaginable and expressed doubt that any design team could have planned and developed an adequate weapons system in the time available.

Requirement originated in the Bloss committee. It spelled out a land-based fixed-wing aircraft with a speed of approximately 60 kt. faster than the Lockheed P2V series now in service with NATO ASW units in the Netherlands, Italy and France.

Final details originated about a year ago. The Bloss Committee decided it was to be an entirely European aircraft produced in Europe, thus ruling out the possibility of American companies at the start.

A contractor like Lockheed could not enter the Electra ASW version unless it was willing to turn over the complete job to European companies.

Specifications were circulated to U.S. firms finally on Decoration Day weekend, leaving about three weeks for readying proposals. Most companies realized the task was hopeless.

Design will be evaluated by the NATO committee supplemented by technicians attached to the committee from competing companies. A decision is expected by mid-September.

Company Grouping

Grouping of companies in order to spread proposed production over a number of firms and countries was strongly urged by covering letter that accompanied the requirements.

U. S. Navy Cmdr. Grady Owens, of EUCOM (U. S. European Command), only American serving on Bloss committee, declined all comment.

Mutual weapons development team, one of the first groups brought into any European aircraft program because of its influence on future financing, is not yet formally involved in the program.

But there is no doubt that if the ASW competition ever results in a tangible order, it will have to be financed by United States funds under the mutual weapons development program.

Among the firms reported or expected to have submitted proposals were: Fairey Aviation Co., Ltd., A. V. Roe and Co., Ltd., and Short Bros. and Harland, Ltd., all from England; S. A. des Ateliers d'Aviation Louis Breguet, Societe de Construction des Avions Hurel-Dubois, and Sud Aviation, all from France, Dornier-Werke GmbH., from Germany; Piaggio and C., from Italy; and Fokker from the Netherlands.

Fairey has said officially "no comment;" Short Bros. also said "no comment," but are now known not to be in the competition. An Avro spokesman said he could make no comment either, because "all the company directors were on holiday." However, this company is known to be a contender in a five firm group.

Some of the reported contenders did not take the competition too seriously. One implied that its engineers submitted something because they were asked to, and that they expected nothing to come of the program. Another company suggested that they expected the same political and technical fight that characterized NATO's lightweight strike fighter competition, another airplane that originated in committee.

Observers said some of the competing firms had no concept of a modern ASW aircraft, but simply laid out any airplane that came within the frame of the specifications and drew in a lot of black boxes labeled wih appropriate signs. Lack of understanding of the complexity of modern anti-submarine warfare and weapons system concept led to an under-estimation of the job, they felt.

Word of the competition was finally ferreted out by American representatives in Europe making their routine rounds through the NATO channels. They vociferously demanded to be let in, but already it was too late. Belatedly though, the requirements were sent to ten American firms, but none of these had time to make a careful analysis of the specifications, develop a weapons system concept to do the job and then design the airborne component of the system.

Martin, frustrated by the imposed time limit, submitted instead a proposal to be named manager for the program, regardless of the final winner. Company pointed to its systems-oriented management concept and its past experience in a variety of projects including naval aircraft used for anti-submarine work.

Breakthroughs in equipment and techniques needed by the U.S. Navy if it is to meet the challenge of the Soviet missile submarine were recently detailed by Aviation Week in a series of two articles on Task Force ALFA, special ASW research-training group that first put to sea in April (AW July 14, p. 32; July 21, p. 73).

Germans View Copter

Two American and two British helicopters were demonstrated to German Naval Weapons Command officers at Kiel last week in an exhibition of rotary-wing capabilities in a variety of tasks.

Sikorsky and Vertol flew their S-58 and H-21 models respectively. Westland demonstrated the gas-turbine powered Wessex and the Whirlwind Mk. 7 version of the Sikorsky S-55 built under license.

Both American helicopters demonstrated mine detection and sweeping, air rescue operations, and towing disabled surface craft and bogged-down land vehicles. Westland demonstrated only sonar operations. Companies were invited to the performance by the head of the German Speerwaffenversuchsschule (blockade research school).

There are reports that the Germans plan to buy about 50 helicopters specifically for naval duties. Helicopters so far purchased for the German forces have gone to land and air units.

• **Air Research and Development** Command—Approved $26.6 million of the $27.7 million requested.

• **Air Training Command**—Approved $17.5 million of the $29.5 million requested for implementation of the command's basic training mission and for certain Strategic Air Command and Air Defense Command missions at Training Command facilities. Major items eliminated were $5 million for facilities at Lowry AFB, Colo., $3.5 million for a new parallel runway at Connally AFB, Tex.

• **Continental Air Command**—Approved $12.1 million of the $13.5 million requested.

• **Military Air Transport Service**—Approved $10.6 million of the $10.8 million requested.

• **Strategic Air Command**—Reduced requests of $179.4 million to $158.4 million.

• **Tactical Air Command**—Approved $17.8 million of $23.7 million requested.

• **Aircraft Control and Warning System**—Approved $150 million, a cut of $13.9 million.

• **Ballistic, defense and strategic** missiles—Reduced requests of $272.5 million to $182.5 million. The $90 million cut represents the amount requested by Air Force for the first underground bases for the Titan intercontinental ballistic missile. The committee said it was denying the request because architect-engineering work for certain portions of the Titan facilities will not be completed before next February or April.

Northrop and Arma Resume Merger Talk

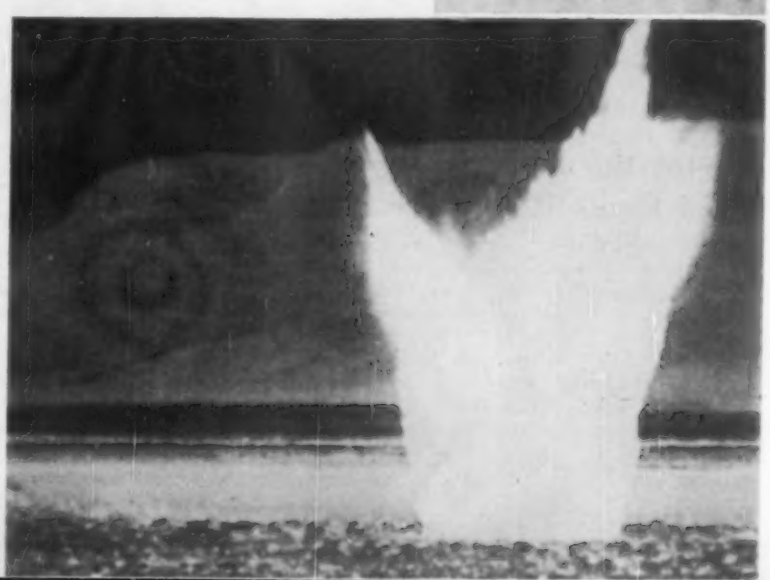
Los Angeles—Top officials of Northrup Aircraft Co. and American Bosch Arma Corp. met again last week to continue discussions aimed at possible merger. Current discussions are a resumption of negotiations which terminated in 1956 when Northrop began merger talks with Vertol Aircraft Corp. which later fell through.

Present plans call for a one-for-one exchange of common stock. Stock of both firms is selling for around $25 per share. Company probably would be called Northrop-Arma Inc., with Northrop's Whitley Collins as chairman of the board and Arma's Charles W. Perelle as president.

Combined company would have annual sales in excess of $400 million, employ nearly 30,000. Northrop's contribution to these figures would be roughly two-thirds. Arma holds sizeable inertial guidance contracts for Air Force ballistic missiles and produces radar-directed defensive armament for the B-52. Merger would broaden Northrop's expanding avionics efforts.

B-58 Hustler Drops Detachable Pod On New Mexico Range

First photos of Convair B-58 Hustler dropping its detachable pod were taken over test range near Holloman AFB, N. M. Test pod was unarmed. Top photo was made from an escort airplane; second was taken from above pod immediately after release by a camera fitted on board the B-58. Other three pictures were taken from a ground installation; bottom photo shows a geyser of dirt thrown upward by the impact of the pod. Supersonic bomber can carry different types of pods, diversifying missions.



ft. in length to be erected within the perimeter of the semi-circle and illuminated by organ-pipe scanners installed in four radar scanner buildings. Reflectors are being developed by D. S. Kennedy & Co., scanner systems by GB Electronics Corp.

Both companies are working under subcontracts from General Electric, which in turn has the responsibility for the detection radars under a subcontract from RCA. General Electric is developing the transmitting and receiving equipment for these radars as improved versions of equipment the company developed for the AN/FPS-17 missile tracking radars installed in Turkey and Laredo, Texas (AW Oct. 21, p. 26).

Tracking Radars

Parabolic antennas of the three tracking radars to be installed at each site will be mounted within radomes on the roofs of the three radar transmitter buildings. Proposed parabolas are 90 ft. in diameter, radomes will be either 144 or 168 ft. depending on whether this or a larger parabola is finally selected.

RCA presently plans to build the transmitting and receiving equipment for the tracking radars, utilizing knowledge gained at Massachusetts Institute of Technology's Lincoln Laboratories during development of the Millstone Hill radar. RCA has subcontracted with Goodyear Aircraft Corp. for development of a working prototype of the tracking antenna and pedestal.

Some competition is developing in this area. Goodyear apparently does not have a prototype ready for acceptance tests but does anticipate obtaining the production contract from RCA for fabrication of the six parabolas and pedestals for the present BMEWS requirement.

Other manufacturers with antenna systems ready to undergo acceptance tests wish to compete for this contract when RCA is authorized by the Air Force to award it. Two of these competitors are D. S. Kennedy and GB Electronics. Kennedy built the 84 ft. parabola for the Millstone Hill radar. GB Electronics last week turned over to the National Bureau of Standards, Boulder, Colo., a 60 ft. antenna and pedestal capable of expansion to 90 ft. which will be used for satellite tracking, scatter propagation studies and radio astronomy.

Passageway connecting the radar buildings at each site will be extended to a service area which will include an electronic maintenance shop, cafeteria and emergency dormitory building, power distribution station and a combined heated garage and fire station.

Power for the Thule installation will be supplied by a Navy YFP-10 floating power plant which will be moored in a specially-constructed closed slip near the main dock. Ship has three steam turbine generators each rated at 11,500 kw. This ship presently is being refitted at Fort Lauderdale, Fla., after having been leased by the Navy for about two years to Florida Power and Light Co.

First package of construction contracts will have been negotiated by Aug. 15 by the Corps of Engineers. In addition to work at the BMEWS site, these contracts will call for construction at the main Thule base of facilities for BMEWS personnel. These will include:

- Dormitories. Five airmen's dormitories, each capable of housing 200 men, will be built this summer.
- **Bachelor officers quarters.** Two BOQ's, each housing 48 officers will be added.
- **Communications.** An addition will be made to the base telephone building.
- **Crypto Vault.** The base crypto vault and incinerator building will be enlarged.
- **Library.** An administration and technical library will be constructed.

Further new buildings and additions to be constructed include materiel and food storage facilities, mess halls, access roads and parking areas for personnel.

To meet the goal of having the system operational in 1960, a peak total of 1,600 construction workers will be employed at each site—exclusive of service personnel and electronics technicians.

Air Force management of the BMEWS program is centered in the BMEWS Project Office, New York City. Actual supervision rests with representatives of Air Materiel Command and Air Research and Development Command, with AMC acting as USAF's executive agent. Participating for purposes of coordination and liaison are representatives from Air Defense Command, Air Training Command, and the Royal Canadian Air Force.

Army Corps of Engineers functions as the Air Force construction agency under the Air Force Installations Representative. Technical effort of contractors and subcontractors is monitored by ARDC representatives and provision made for technical consultation with ARDC centers and personnel where requested. AMC representatives approve subcontracts and financing of contracts for the program.

House Unit Cuts Construction Bill

Washington—Criticizing "lack of realistic planning," the House Appropriations Committee last week slashed $511.8 million from the military construction requests, cutting the total from a requested $1.7 billion for Fiscal 1959 to $1.2 billion.

Air Force was reduced $300 million to $701.5 million; the Army was cut by $126.3 million to $214.5 million, and the Navy by $85.5 million to $282.7 million. The Advanced Research Projects Agency requested and received approval of $50 million.

Despite the cuts, the committee said the importance of the military construction program to defense is often overlooked by military planners, especially in connection with new weapon systems and technical equipment. It added that planning for the implementation of these systems provides for the construction of facilities as an afterthought.

As a consequence, it said that the construction of facilities for actual use of weapon systems has lagged or been so inadequate as to sometimes require either a crash construction program or submission of requests for funds based upon little, if any definitized, planning.

During the hearings on the bill, earlier, Malcolm A. MacIntyre, Air Force undersecretary, testified that $77 million was being requested for construction of 10 additional operational sites for the Boeing Bomarc interceptor missile. He said the Bomarc's progress has exceeded initial expectations with its "amazing" accuracy and high altitude capability.

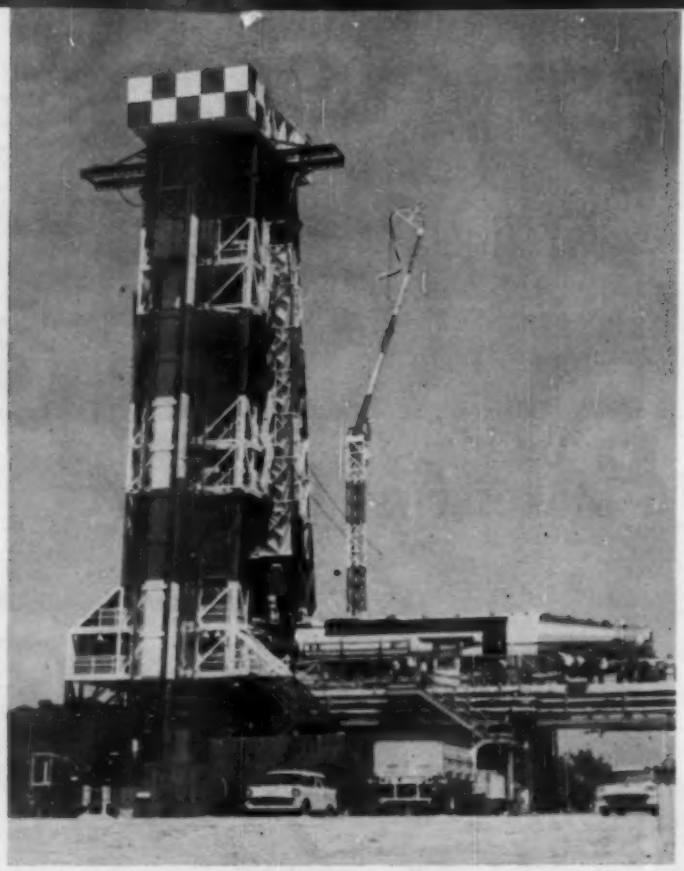
The committee, however, cut funds request for Air Defense Command from $77.9 million to $65.2 million. Included in the $12.6 million cut were funds for ADC facilities located on bases where Bomarc installations are scheduled. These are Duluth AFB, Minn.; Ethan Allen AFB, Vt.; Kinross AFB, Mich.; Niagara Falls AFB, N. Y., and Truax AFB, Wis.

The committee took this action on other continental U.S. Air Force requests:

- **Air Materiel Command**—Reduced requests of $49.1 million to $37.3 million. Among items eliminated are $1 million for an armament and electronic depot at Tinker AFB, Okla., $7.4 million for an academic training facility at Wright-Patterson AFB, Ohio.

Japan's Mach 3 Plans

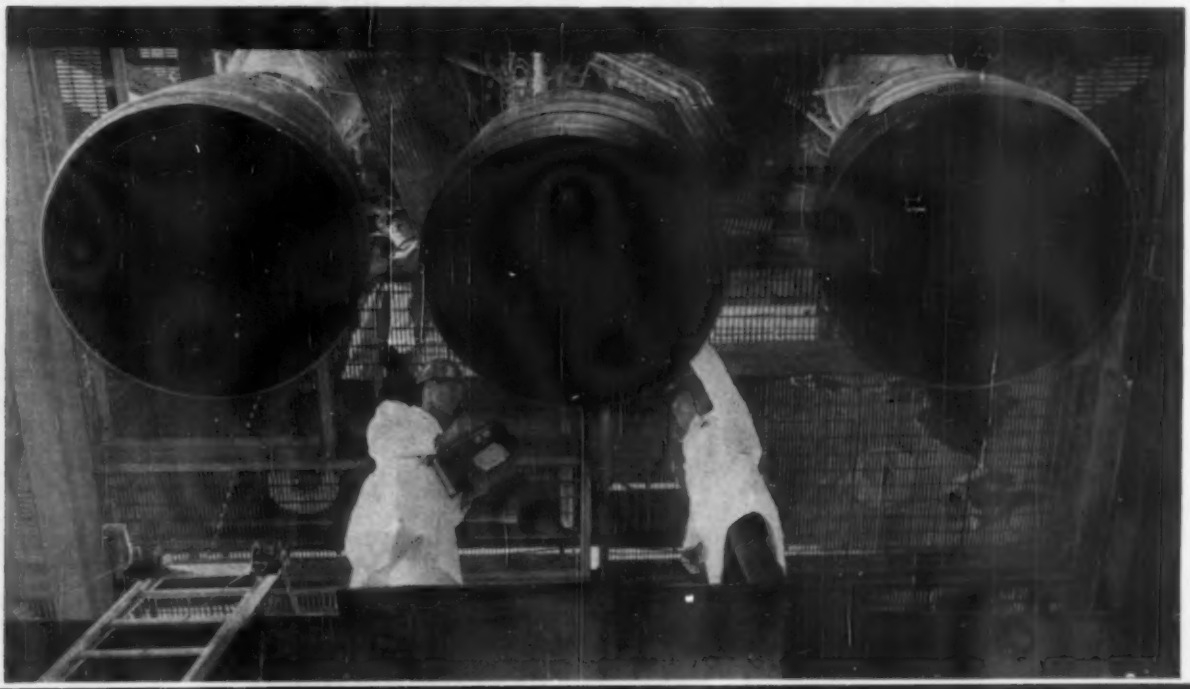
Tokyo—Japanese government is proceeding with plans to develop a Mach 3 interceptor as a follow-on fighter to be phased in after the Grumman Super Tiger which will be built under license in Japan. Three Japanese firms, Mitsubishi, Kawasaki and Fuji Heavy Industries have submitted design proposals for the Mach 3 interceptor. Japanese government plans to allocate funds for preliminary development of airfoils, afterburner and turbine blades for this aircraft during the current fiscal year.



View of Atlas-B (above, left) from overhead shows intercontinental ballistic missile, on its handling trailer, being backed into position for erection in test tower at Edwards AFB, Calif. Gooseneck boom (above), at right of tower, is new feature of launch pads at Cape Canaveral, Fla. Boom carries power and instrumentation lines to nose cone. First fully-powered Atlas-B (above, right) veers off course prior to being destroyed. Malfunction of control system produced sufficient yawing and pitching motion to break missile in two.

t Launches Atlas-B ICBM on First Flight

First picture of Atlas-B's engine nozzles shows 60,000 lb. thrust sustainer nozzle at center and 165,000 thrust booster nozzles at sides.



Guidance Changes Made on Atlas, Titan

Washington—Changes are being made in guidance systems employed on the Atlas and Titan intercontinental ballistic missiles. They include:

• **Atlas, originally slated to use** a radio command guidance system developed by General Electric and Burroughs (AW April 28, p. 74), will eventually employ an all-inertial system developed by American Bosch Arma Corp. (AW May 12, p. 92).

• **Titan was designed to use either** the Arma all-inertial system or a radio-command guidance system being developed by Bell Telephone Laboratories and Remington Rand Division of Sperry Rand Corp. It now appears that Titan will use radio-command guidance until Arma's production of inertial guidance climbs to a point where sufficient inertial systems are available to meet both Atlas and Titan production schedules.

Reason for the switch from GE/Burroughs radio-command guidance to Arma's inertial guidance has not been disclosed but appears to stem from inherent advantages of inertial systems rather than as a reflection on performance of GE/Burroughs system which reportedly meets original design requirements. Reasons for the changeover are believed to include:

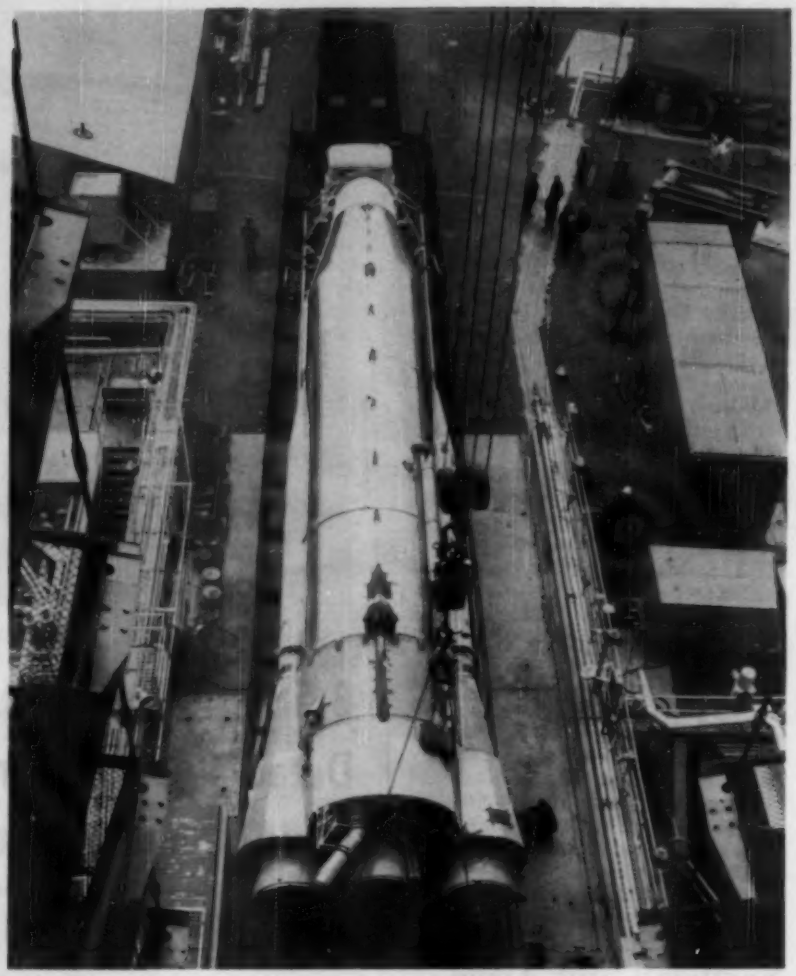
• **Mass Salvos of ICBMs can** be launched simultaneously from a base if they employ inertial guidance, but not when radio-command guidance is used.

• **Inertial guidance is invulnerable** to enemy countermeasures, whereas radio-command system may be jammable. However, extremely sophisticated security techniques employed in GE's guidance system made it practically impossible to jam, according to company spokesman (AW June 30, p. 48).

At the start of the Atlas and Titan programs, it was not known whether the state of the inertial art would provide adequate accuracy and reliability in time for either missile. This explains why Atlas was originally scheduled to use radio-command guidance, and an alternative radio-command guidance was developed for Titan.

Vertol Earnings Sink To 4 Cents Per Share

Vertol Aircraft Corp. earnings sank to 4 cents a share in the second quarter on net earnings of $22,386. Six months totals for the helicopter company showed sales of $21,081,261 compared with $41,952,442 for the same period last year; net earnings of $185,021 compared with $1,322,079 and per share earnings of 29 cents compared with $2.10.



Three-Engined Powerplant

First fully-powered Atlas intercontinental ballistic missile, designated Atlas-B, was fired from Cape Canaveral, Fla., on July 19 and was destroyed after a flight lasting two minutes. Cause of the abort was a malfunctioning control system that produced sufficient yawing and pitching motion to break the missile in two.

No attempt had been made to send the Atlas-B on a full-range flight. Firing was part of program to test joint capacity of the three engines (one sustainer, two boosters) plus the separation of the booster engines and the re-entry nose cone. Note blunt shape (top, right).

Atlas missiles fired previously were powered only by the two boosters and were limited to a range of approximately 600-800 mi.

Principal changes in the fully-powered version of the Atlas, now being produced in test quantities at Convair Division of General Dynamics Corp., San Diego, Calif., are:

• **Sustainer engine** has been positioned between the two booster engines.

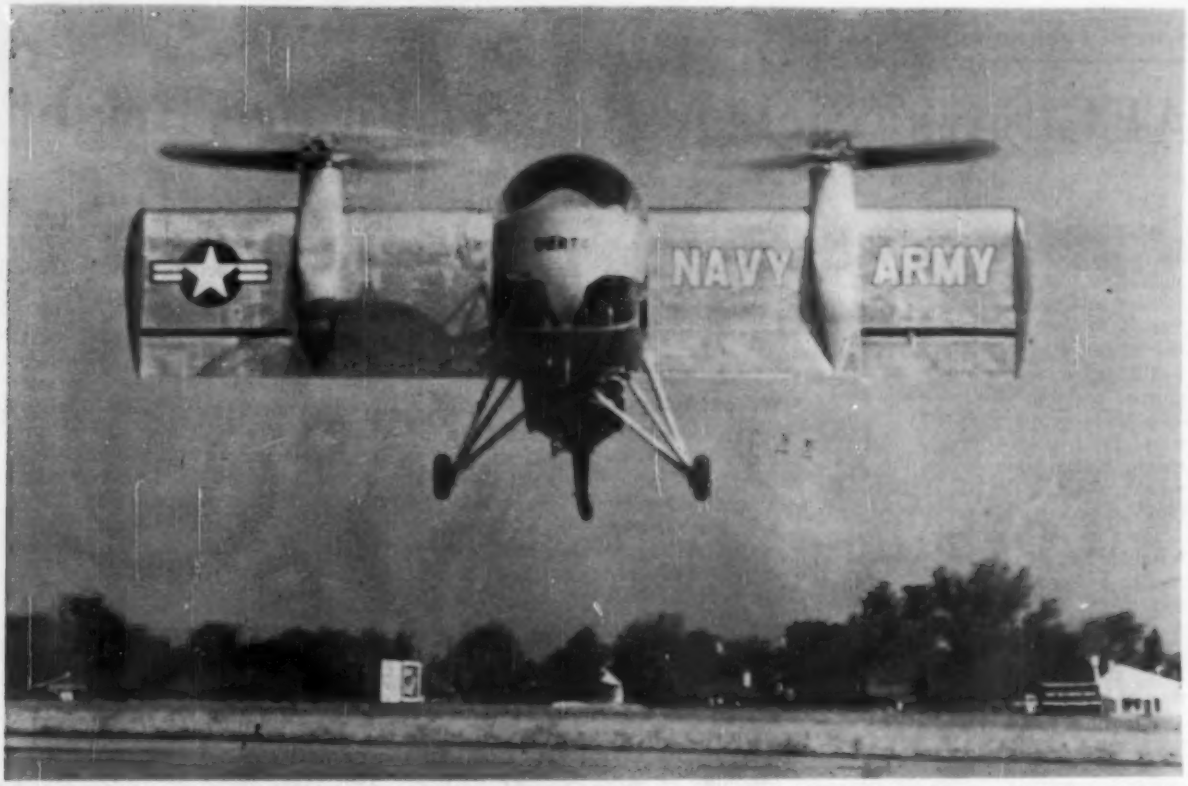
• **Staged jettisoning** of boosters and associated equipment after first few minutes of flight.

• **Addition of separable** re-entry nose cone designed to carry nuclear warhead. After final engine shutoff, nose cone is separated from the missile and proceeds independently to target.

Atlas-B has Rocketdyne sustainer and two boosters, but only one propellant tank structure. All engines are ignited on ground. At staging boosters are dropped and sustainer continues to burn. Sustainer has thrust of 60,000 lb. and the boosters have a combined thrust of 330,000 lb. (AW Mar. 17, p. 20).

Atlas is approximately 90 ft. tall and is one year ahead of the USAF's other ICBM—Martin's two-stage Titan.

To date there have been three successful Atlas launchings out of nine attempts. At least one full range flight is scheduled for this fall.



MODEL 76 with wing in vertical position takes off for first transitional flight. For takeoff and landing wing tilts to a 84-86 deg. angle; for horizontal flight wing is positioned at an incidence of 9 deg. Aircraft's wingspan is 24 ft. 11 in.; length of fuselage 26 ft. 5 in. Two rotor propellers and two tail fans are driven by single T53. Tail fans are used for control in the helicopter hovering condition, one installed horizontally to control pitch and one placed vertically to control yaw. Altitude during first transitional flight was held to 20-25 ft.

Ballistic Missile Group To Advise ARPA

Washington – Ten scientists have been named to newly formed Ballistic Missile Defense Division of Institute of Defense Analysis to serve as technical consultants to Advanced Research Projects Agency Director Roy W. Johnson and ARPA Chief Scientist Dr. Herbert York.

Function of the newly formed group headed by William Hutchins (AW July 7, p. 30.) is to explore advanced techniques and evaluate proposals by individual services or contractors for advanced studies in ballistic missile defense area, making recommendations to Johnson and York.

Group will not be directly involved in Army's Nike Zeus anti-missile missile program, nor in Air Force's Ballistic Missile Early Warning System (BMEWS), which are directed toward coming up with solutions to the more immediate ballistic missile threat. In line with ARPA's assigned responsibilities, the new group will seek techniques which can be used to counter more sophisticated ballistic weapons of the future.

Four panels already have been formed within the new group, and additional panels will be announced soon. Present panels, their chairman and their former company affiliations are as follows:

- **Upper atmospheric physics:** Dr. Ward C. Low (Sylvania).
- **Very early warning:** Dr. David Luck (Radio Corp. of America).
- **Instrumentation & special ranges:** Dr. Glen Pippert (Lincoln Laboratories).
- **Destruction mechanisms:** Dr. Wade Blocker (Ramo-Wooldridge).
- **Anti-satellite:** Dr. Leroy Tillotson (Bell Telephone Laboratories).
- **Active defense:** Dr. Richard Holbrook (Rand Corp.).
- **Interception:** Clifford Cummings (Jet Propulsion Laboratory).
- **Data processing for decisions:** Stewart Hight (Sondia Corp.).
- **Radar:** Harry Iddings (GE).

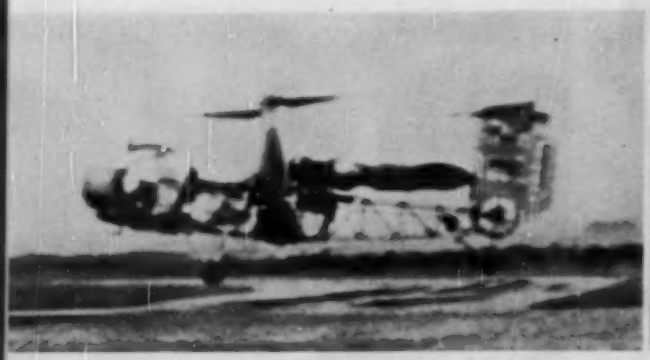
Purchase Negotiation

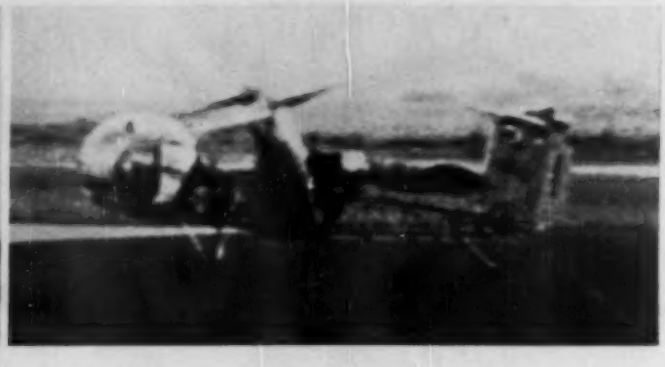
Marquardt Aircraft Co. is negotiating with American Machine & Foundry Co. regarding the possible purchase of an AMF division, the Associated Missile Products Co., an avionic firm located in Pomona, Calif. Tentative recommendations covering the proposed transaction probably will be made by Marquardt next month at a New York meeting of American Machine & Foundry's board of governors.

U-2 Grounded

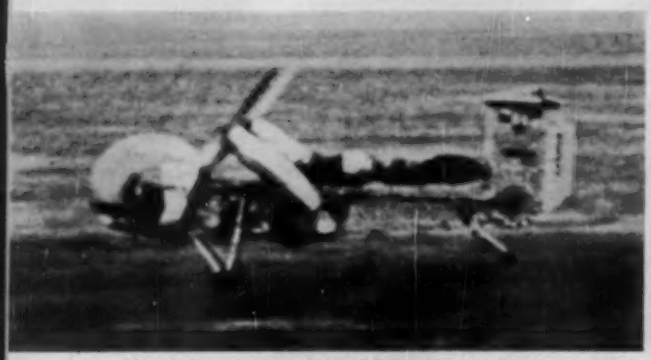
Washington—Air Force has grounded its Lockheed U-2 high altitude aircraft pending results of investigations of two recent crashes in New Mexico within a 24 hour period. National Advisory Committee for Aeronautics also grounded its U-2s, which it uses for weather research, for a short period but has returned the aircraft to flying status.

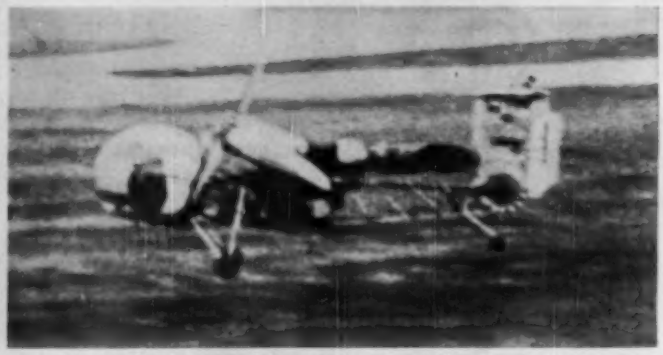
Russian Air Force journals make frequent mention of the U-2, especially those assigned to the Strategic Air Command. The Red Air Force newspaper, Sovetskava Aviatsiva reports to Soviet airmen that the U-2, ". . . lacks all identification marks indicating its mission." The magazine also noted, ". . . the U-2 has been accepted by U. S. Strategic Air Command (units) and has made repeated flights from the American base at Wiesbaden, West Germany." The publication suggested that these U-2 flights were for the purpose of strategic reconnaissance.





Vertol's Model 76 Makes First Transition





Vertol Aircraft Corp.'s Model 76 tilt-wing VTOL makes first transitional flight at Philadelphia International Airport. Photo sequence shows position of wing and nacelles for takeoff and tilt of wing as aircraft moves forward into horizontal flight. Model 76 is first tilt-wing aircraft to go through complete flight transition. Aircraft was developed for U. S. Army, under a contract with the Office of Naval Research and is powered with a Lycoming T53 engine derated to 600 eshp.

Soviet Aviation Show Plays Down Military, Accents Civil Aircraft

Moscow—Soviet Union displayed only civil and light aircraft at its aviation day flying exhibition. This was in strong contrast to previous years when the accent normally was on military aircraft.

Only new equipment demonstrated was the "Flying Table," vertical takeoff test bed similar to Rolls-Royce Flying Bedstead or the French Flying Atar, Flying Stand or Turbolet (AW Jan. 27, p. 28)..

Even the Tu-114D, which has been heavily publicized recently for its long distance flights, failed to put in an appearance before the crowd of 250,000 at Tushino Airport.

Transport Mi-6 Flyby

Other than the vertical takeoff rig, a flyby of Soviet turbojet and turboprop airliners and of several Yak-24 tandem rotor helicopters was main feature of air show. There was no static display.

This show was the first since the military show two years ago to which USAF Chief of Staff Gen. Nathan Twining, other foreign observers and Western journalists were invited. Last year's show was cancelled due to weather and a top-level political shake-up.

Russian vertical takeoff rig, making its first public appearance took off from a concrete pad partially hidden from observers by an intervening road and screen of trees. Vehicle is powered by a single turbojet centrally mounted on a cross frame with flow bled off to control jets on its four legs. Pilot sits 8-10 ft. off the ground on a platform mounted adjacent to engine. The rig demonstrated considerable vertical and lateral maneuverability although it never at any point tilted very far off the vertical axis.

Noisy demonstration included vertical climb to about 250 ft. as well as rotation around its axis.

One new feature this year was the participation of satellite pilots and aircraft from Czechoslovakia, Poland, Bulgaria and Rumania.

Flyby of the major civil transports consisted of one solitary pass by each of them at an altitude of approximately 600 ft.

First to put in an appearance was the Tu-114 turboprop which initially was shown last summer at special display. This was followed by a Tu-104A twin turbojet. Then came the Il-18 Moskva turboprop trailed by the An-10 Ukraina.

Little Bee

Also demonstrated was the Antonov Little Bee air taxi, a twin piston engine airplane designed for short field feeder line service.

Light aircraft taking part in formation flying and aerobatic demonstrations included the Yak-18, standard Soviet primary trainer, Czech 226 trainer which has fixed gear, a Rumanian monoplane trainer called Buker 133 and the Rumanian IAR-81 low wing light aircraft.

The helicopter flypast also included the small Ka-10 and Ka-15 coaxial configuration.

be used for Pluto tests are in the area known as Jackass Flats.

AEC's work on nuclear propulsion projects for atmospheric and space vehicles began formally in the fall of 1955 at Los Alamos and Livermore laboratories, with Defense Department expressing "intense interest" but requesting that it not be allowed to interfere with weapons programs.

In mid-1956, missile czar Murphree appointed a 10-man committee under Secretary Wilson's atomic energy aide, Gen. Herbert B. Loper, to "determine the prospects of meeting the original requirement for testing the rocket's nuclear powerplant by a certain date within the next few years," according to Sen. Clinton P. Anderson (D.-N. M.), vice chairman of the Joint Committee.

The Loper Committee called for a "prompt effort to demonstrate the technical feasibility" of the project because of its potential value for ICBMs.

"Mr. Murphree, who had spent his life with chemicals and chemical fuels and gasoline and similar substances, cut back Project Rover before the Loper Committee had given him advice as to whether or not Project Rover should be cut back," Sen. Anderson said.

Before the formal Loper report was issued, Murphree prepared for Wilson's signature a letter to the AEC calling the feasibility and flight test schedule "unrealistic" and asking AEC to "continue (the project) on a moderate scale," Anderson said.

Pending the Loper report, Budget Bureau had held back severely on operating and construction funds. Following Wilson's letter, it reduced construction funds by $10 million and operating funds by $6 million for Fiscal 1957.

This forced AEC to kill off the Rover work at Livermore. With a reduced program, the Fiscal 1958 budget also was low. "The ground rules for 1959, which were indicated to AEC, were that efforts were to be carried on at approximately the same level as 1958," Anderson said. "The net result has been the moving back or delaying of the target date for demonstration of feasibility by at least two years from that which was set out in the directive of the Loper Committee."

AEC and USAF witnesses declined to say the cuts had caused a two-year delay, preferring to say that it had cost the project "some insurance" of getting a working engine in the time projected. AEC witnesses said trimming of the program postponed investigation of "long-range" possibilities for propulsion, leaving concentration only on the short-range work.

Rover, a high temperature gaseous reactor that will use helium or hydrogen, now is being continued at Los Alamos and with contractors. Second reactor to be tested is called Dumbo, and is a slightly different approach. It will be tested late in 1960, testimony indicated.

USAF contractors on other portions of the Pluto ramjet engine are Curtiss-Wright Corp. and Marquardt Aircraft Co. Curtiss-Wright also worked with Livermore Laboratory, apparently before Rover work was terminated there. Atomics International Division of North American also has done basic materials research for Pluto.

Pluto's test program includes putting a mock-up reactor in an atomic "oven" in Nevada at 1,300F to determine temperature effects on changes in criticality. Then will come test of the Tory II reactor, which "nuclearly and materialwise is a scale model" of the one that eventually will fly a ramjet.

Minuteman Contractors

Washington—Air Force last week asked Defense Department for release of further funds for development of the Minuteman solid fuel intercontinental ballistic missile and selected contractors to design the missile's nose cone, guidance system and propulsion units. Signing of contracts and official commencement of this work on the missile's main components will not begin until funds have been released by the Defense Department.

Announcement of a prime or weapon systems contractor has not been made and, according to an Air Force spokesman, this selection will not have to be made until work with the major components has progressed for several months.

Companies selected last week and their development responsibilities are:

- **Nose cone—Avco Manufacturing Corp.**
- **Guidance System—Autonetics Division of North American Aviation Inc.**
- **First stage engine—Thiokol Chemical Corp. with limited backup by Aerojet General Corp.**
- **Second stage engine—Parallel development programs will be conducted by Thiokol and Aerojet with each firm stressing a different engine case.**
- **Third stage engine—Aerojet with limited backup by Thiokol. Hercules Powder Co. will also be contracted to study the possibility of using double-base propellants. By tradition, the term double-base refers to propellants containing nitrocellulose and nitroglycerin which are combined chemically into a homogeneous substance containing both fuel and oxidizer.**

Air Force management of the Minuteman program will be handled by Ballistic Missile Division with technical advice supplied by the Ramo-Wooldridge Corp.

A total of $4 million in contracts already related to Minuteman have been assigned for the development of swiveling nozzles for use with solid fuel rockets. This money was divided between two programs, one conducted by Thompson Products Inc., the other by Bendix Aviation Corp. Beech Aircraft Corp. also has received a $62,000 contract for transporters.

VTOL Jet Controls

San Diego—Ryan Aeronautical Co. is developing a jet reaction control system to function efficiently with afterburner in a tactical type vertical takeoff and landing plane for the Navy.

Contract from Navy Bureau of Aeronautics follows successful demonstration of VTOL principles in company's experimental X-13 vertijet.

First phase of work to develop more advanced VTOL jet reaction control system, for tactical operations, has been started in Ryan's jet engine test cell, utilizing General Electric J79 turbine engine.

Thor Able Launched In Nose Cone Test

Cape Canaveral, Fla.—Air Force fired its third, and last, two-stage Thor Able research missile from USAF Missile Test Center last week in tests of a sophisticated ablation-type nose cone.

Last week's tests was apparently successful, with the nose cone falling into the impact area and transmitting telemetered data throughout the 6,000 mi. —plus flight. The three shots also were used to gain experience necessary for lunar probe shots and, incidentally, to gather physiological data from an instrumented mouse housed in the nose cone.

The first two mice were not found; a search was still under way for the third mouse late last week. Apogee obtained in third firing was estimated at approximately 1,000 mi.

Next firing of the test vehicle incorporating a solid-propellant third stage may be an attempt at a lunar probe.

In the firings of the ablated nose cone, which is similar to the ones used on Army's Jupiter and differs from the simpler blunt heat sink types developed for USAF's Atlas and Thor intercontinental ballistic missiles, Air Force was seeking to determine how much the weight of the cone could be decreased and still be successful.

Savings in cone weight could be applied to the payload, either warhead or instrumentation.

AEC Says Nuclear Rocket Future Bright

By Evert Clark

Washington—Strong optimism over the feasibility and future importance of nuclear rockets and ramjet engines for missiles and space flight has been expressed to Congress by the Air Force and Atomic Energy Commission.

Although a meager budget has slowed progress and a great many major development problems still must be overcome, the two agencies and their contractor teams hope to fly the Rover nuclear rocket by the late 1960s and the Pluto nuclear ramjet even before that.

Their optimism foresees:

• **Rugged "flying crowbar" missile** powered by a ramjet that uses only air as its fuel. With relatively unlimited range, it might cruise constantly. It would have the capability to "come in on the deck" at very high speeds, avoiding any type of anti-missile interception except a stern chase from a base far out from the target.

• **Nuclear rocket that could put** a 100,000 lb. satellite into a 200 mi. orbit or throw a warhead of the same weight for 8,500 mi.

• **Two-stage Rover** that would propel space ships on flights as far away as the planet Jupiter.

This favorable outlook for nuclear propulsion engines was expressed in testimony given earlier this year before subcommittees of the Joint Atomic Energy Committee and released last week after considerable censoring.

Wilson Delays

The testimony also disclosed in some detail how former Pentagon missile czar Eger V. Murphree, former Defense Secretary Charles E. Wilson and the Bureau of the Budget forced researchers to abandon some of their approaches to the Rover rocket, and delayed by several years the theoretical investigation of other possible methods of nuclear propulsion, including the bomb powered rocket.

Advanced Research Projects Agency recently awarded General Atomics Division of General Dynamics Corp. a $1 million contract for the first study of the feasibility of using explosive force of nuclear fuel to propel a vehicle (AW July 7, p. 25), although the basic idea is more than 10 years old.

The hearings also revealed that three different approaches are being made toward providing electrical power for USAF's Sentry (formerly Pied Piper) reconnaissance satellite. This power project is called SNAP, for secondary nuclear auxiliary power.

One of the approaches, first suggested by work done in Russia, involves a solid thermoelectric converter that has obtained 8% efficiency and promises 15 to 25% efficiency. It would provide three watts of power for six months.

Three Approaches

Three approaches are:

• **SNAP I uses radioactive isotope** (cerium 144) as its heat source. The Martin Co. is the prime contractor and Thompson Products has a subcontract for the rotating machinery. Cerium 144 costs seven cents per curie compared to $10 for polonium.

• **SNAP II uses a thermal reactor.** Prime contractor is Atomics International Division of North American Aviation Inc., with Thompson Products building the machinery, apparently the same that will be used in SNAP I. Air Force Col. Jack Armstrong, deputy chief of AEC's Aircraft Reactors Branch of the Reactor Development Division, said Atomics International "is so extremely interested in this thing I think you will find a lot of their money in it because this was carried through to a design critical stage for a total cost of everything—facilities, research, materials, the works—for $885,000."

• **SNAP III. Thermoelectric converter** which resulted from work sponsored by Navy at Westinghouse Electric Corp. and with company funds. Interest at Westinghouse was aroused by Russian technical literature. It would use polonium isotopes as the heat source, a mixed valence oxide and wires to carry off the electricity produced. Unit to be used with Sentry would weigh no more than 10 lb., produce three watts for six months. Westinghouse offered it to the project for $25,000, according to testimony. Radiation will not damage and may improve the material used.

Rover Test

First test of a ground based reactor, called Kiwi A, for the Rover rocket will take place late this year in the "400 area" of a 12.2 mi. by 39.6 mi. portion of land transferred from the Air Force Las Vegas Range to AEC's Nevada Test Site two years ago. Both the Rover test site and the "401 area" to

Space Observations

Washington—Testimony before subcommittees of the Joint Atomic Energy Committee of Congress released last week but held early this year contained these observations on the nation's attitude toward space projects:

• "Six months ago, sir, when I talked about satellites, people looked for a man with a white coat to come and get me. Today, if you don't know about satellites, you are stupid."—USAF Col. Jack Armstrong of Atomic Energy Commission's Aircraft Reactors Branch.

• "Until the Sputnik was flown there was a rather definite over-all atmosphere of lack of interest in space travel or satellite programs as such. . . . In setting up the IGY satellite, the original program . . . was $10 million and there was some considerable controversy about whether it was worth the $10 million. . . . We are now in the process of putting up $110 million to do what was originally proposed. I say categorically that if $110 million had been tied to the effort as the original price tag, I doubt if it would have obtained sufficient over-all support from either the Department of Defense or the Congress to do it all."—Gen. Austin W. Betts, military executive assistant to the Director of Guided Missiles.

Ostrander to NATO

Washington—Maj. Gen. Don R. Ostrander, deputy commander of the Air Research and Development Command, will be transferred to Europe to take over the newly established post of Assistant for Guided Missile Production to the North Atlantic Treaty Organization.

Gen. Ostrander, who will assume his new duties on Aug. 8, will be succeeded at ARDC by Brig. Gen. Lee W. Fulton, present director of procurement at ARDC.

Assigned to the NATO Office of the Assistant Secretary of Production and Logistics with headquarters in Paris, Gen. Ostrander's duties will include analyzing NATO countries' industrial resources, studying possibilities of production of various missile systems, recommending allocations of industrial tasks, supervising international technical groups connected with guided missile production and obtaining cooperation between the NATO nations for coordinated production of missile systems.

Missiles which may be produced cooperatively by NATO nations include both the Ajax and Hercules versions of Douglas' Nike anti-aircraft missile, Raytheon's Hawk low-altitude anti-aircraft missile, and France's Nord SS-10 anti-tank weapon.

ment to continue to offset rising costs.

Meanwhile, statistics calculated by Foote's office disclosed that, although dollar obligations for research and development rose substantially from $1 billion in Fiscal 1951 to $1.5 billion in Fiscal 1958, the actual "purchasing power" devoted to research and development in Fiscal 1958 was below the Fiscal 1951 level.

Research and development funds were adjusted to a 1947-49 price index —or what the dollars would buy at 1947-49 cost levels. These show:

- **Missile research and development** obligations of $214 million in Fiscal 1953 were down to $152 million in Fiscal 1956. They did not increase substantially (to $287 million) until Fiscal 1958.
- **Obligations for research and development** other than missiles were at a peak in Fiscal 1952 to $972 million. They declined steadily to $624 million in Fiscal 1958.

Two New Aerobees Enter Production

Newest additions to the family of high altitude research rockets sired by Aerojet-General Corp.'s Aerobee are the Aerobee 75, now coming off the production line, and the Aerobee 300, just going into production.

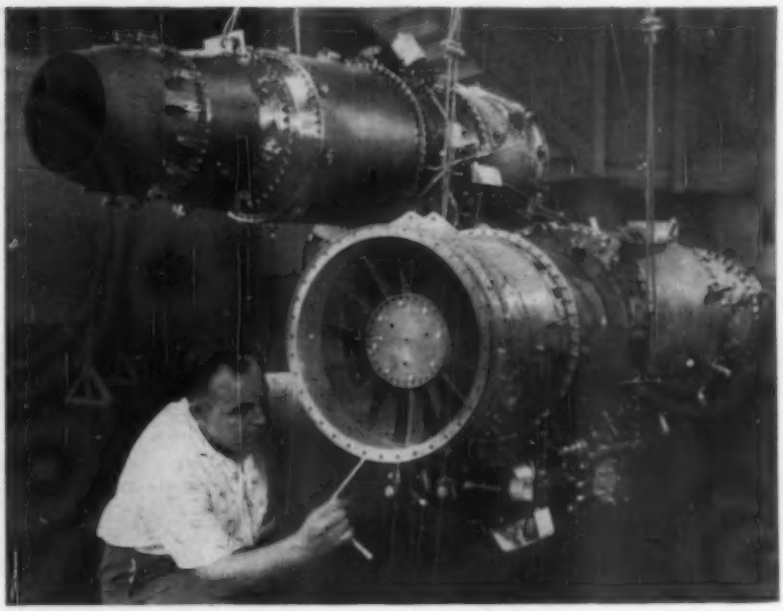
Designed to carry a 90-lb. payload to an altitude of 75 mi., Aerobee 75, also called Aerobee Hawk, employs a dual thrust solid propellant rocket engine in which the booster and sustainer components are combined in a single unit. Over-all length of the vehicle is 205-in.; diameter is 14-in. Cost is approximately half that of the older Aerobee Hi, now redesignated Aerobee 150 in line with new Aerojet policy of naming sounding rockets according to their designed altitude capability. Aerobee 75 can be either rail-launched or it can be tower-launched.

First flight of the Aerobee 75 took place earlier this month at White Sands Missile Range under the aegis of the Army Signal Engineering Laboratory. The rocket carried a 115-lb. payload—consisting of 10 grenades and instrumentation to measure temperature and winds—to an altitude of 60 mi. Present plans call for Aerojet to deliver eight more vehicles.

With an altitude capability of 75 mi., Aerobee 75 becomes the lowest flying vehicle in the Aerobee line, apparently taking the place of the original, liquid propellant Aerobee.

At the other end of the altitude spectrum will come the Aerobee 300, designed to carry a 90-lb. payload to an altitude of 300 mi.

Also known as the Spaerobee, the 300 is a boosted single stage vehicle and will be launched from a tower. Engines and booster are solid propellant rockets.



First Picture of JT12 Engine

New Pratt & Whitney JT12 turbojet engine (AW May 26, p. 23) marks entry of the United Aircraft Corp. Division into smaller jet engine field. Engine, which has initial rating of 2,900 lb. dry static thrust, is scheduled for use in McDonnell UCX jet transport and also is under consideration for conversion of Sikorsky H-37 helicopters to gas turbine power.

News Digest

Martin Co. has been awarded a $385,000 Navy contract for further engineering studies on a nuclear seaplane, including studies of new airframe designs based on present engine developments; powerplant requirements involved in modifying existing airframes—probably the Saunders-Roe Princess—and facilities and handling requirements, operation analysis studies and sheilding techniques. Studies are aimed at development of a turboprop operational system for anti-submarine, early warning or cargo use in the 1964-1965 period.

First Boeing B-52G missile-platform bomber was rolled out of the Boeing Wichita plant last week. New version of the B-52 will carry North American GAM-77 Hound Dog Missiles slung under the wings.

Fairchild Engine & Airplane Corp. last week was to sign its first production contract for USAF's SM-73 Goose surface-launched diversionary missile (AW June 23, p. 29). Production is expected to begin in September.

Contractors associated with the Martin Co. in its design for the Dyna-Soar Orbital bomber competition include Bell Aircraft Corp., American Machine & Foundry Co., Bendix Aviation Corp., Goodyear Aviation Corp. and Minneapolis-Honeywell Regulator Co.

Alitalia Airlines has ordered Conway bypass engines from Rolls-Royce, Ltd., for the airline's four Douglas DC-8 jet airliners. Contract is worth about $5.3 million.

Congress has passed and sent to the President legislation promoting Maj. Gen. Claire L. Chennault, USAF, ret., to the rank of lieutenant general on the retired list. Gen. Chennault, World War II commander of the American Volunteer Group and later the Fourteenth Air Force in China, was seriously ill last week in New Orleans, La.

English Electric P.11, side-by-side trainer version of P.1 jet fighter, has been ordered for the Royal Air Force.

Strike of 1,800 engineers at Radio Corp. of America's Camden, N. J., area plants ended last week after a 10-day walkout. Demand for a guaranteed annual merit raise fund, one of the major causes of the strike, was subsequently abandoned by the Assn. of Professional Engineering Personnel, member unit of Engineers and Scientists of America, an independent union. RCA will work with the union to develop new Merit Review Plan to be instituted early in 1959.

Defense Asked for Long-Range R&D Plan

By Katherine Johnsen

Washington—Defense Department has been asked to draft a 10-year research and development program without consideration of financial limitations, Dr. Paul D. Foote, Assistant Secretary of Defense for Research and Development, told the House Government Operations Committee last week.

The request, he said, was made jointly by the National Science Foundation and Dr. James R. Killian, scientific adviser to President Eisenhower.

Foote told the committee that initial studies indicate that, under the proposed program, expenditures for military research and development would be doubled within seven or eight years. This would mean an increase from $2.3 billion estimated expenditures for Fiscal 1959 to $4.6 billion. The planned Fiscal 1959 level is a sharp increase over the $1.8 billion for Fiscal 1958. During the previous five years expenditures mounted gradually from $1.4 billion in Fiscal 1953.

Defense Department estimates that the proposed program wil be completed for consideration by Killian and National Science Foundation by October.

Foote Defends Policy

Foote challenged testimony by research and development officials of the services that fiscal ceilings and burdensome procedures are hampering research and development progress (AW July 21, p. 26). He defended the "level dollar outlay" policy for research and development which has been challenged by Navy Assistant Secretary for Air Garrison Norton.

Foote also took issue with the recommendation of the ad hoc Stever Committee of USAF's Scientific Advisory Board (AW July 14, p. 29) that authority and responsibility over research and development projects should be decentralized.

Decentralization also has been endorsed by Norton: USAF Assistant Secretary for Research and Development Richard Horner, and Army Director of Research and Development William H. Martin. Foote said:

"Most of the ideas that come out of the Air Force are relayed by the Air Force from their contractors, because most of the development work of the Air Force is done by contractors like Ramo-Wooldridge Corp. . . .

"Contractors make the point—and they are very emphatic about it—that 'you give us the responsibility for doing this and you need not worry because we will take care of it'."

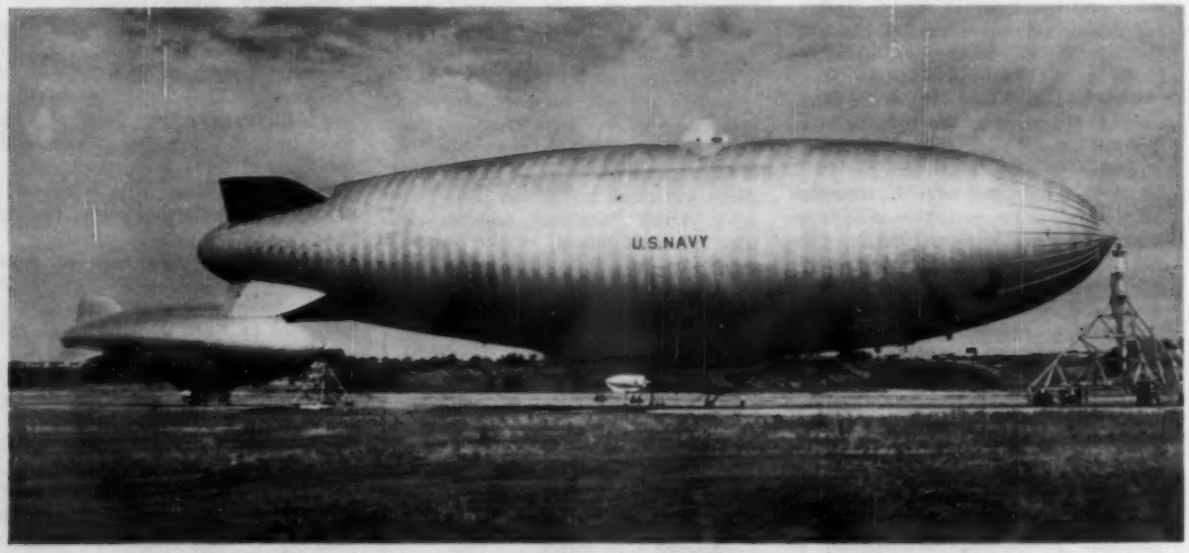
Foote insisted on the necessity for close "higher control" because "the Army has another group of contractors who also say, 'give us the authority and do not question anything we do, and we will give you a satisfactory situation'.

"It is absolutely essential that we bring all of these competing agencies together and discuss their relative merits. That is what they are objecting to. They do not like it."

Money Use

Other points stressed by Foote included:

- **Budgeting and accounting procedures** are not the problem in the research and development program, "but rather the determining of how best to use large sums of money appropriated."
- **"A fairly level, steady program** (dollar-wise) in research and development provides a greater payoff than a program with short ups and down, or one with a crash program content." Foote said he would favor increasing funds for research and development a mild 3% to 5% each year.
- **Although rising costs have affected** the research and development effort, "this has been at least partially offset by greater selectivity in the development of items, improved management by wider use of experienced research management teams and by increasing support of funds from procurement and production accounts." Research and development support from production funds mounted from $1.8 billion in 1955 fiscal year to $3.3 billion in 1958 fiscal year, he said. Improved management and greater selectivity, he estimated, will enable Defense Depart-



ZPG-3W Designed for Early Warning Radar Role

World's largest non-rigid airship, U. S. Navy's ZPG-3W, built by Goodyear Aircraft Corp., is readied for its first flight at Akron, Ohio. Prototype of a new class, airship is designed for airborne early warning. Concealed within the envelope is the largest revolving radar antenna ever carried by any type of aircraft. Structure on top of envelope houses antenna pivot point. ZPG-3W is reported to have an inflation capacity of 1.5 million cu. ft. and is powered by two Wright R1820-88 engines. Normal crew complement will be 21 men. In the background is a ZS2G-1 (ASW) with an inflation capacity of 650,000 cu. ft.

Pyle Says Jet Noise Still Major Problem

CAA Administrator says no easy solution has been found; NACA being urged to increase its research.

By Robert H. Cook

Washington—Jet noise suppression is still one of the major unsolved problems facing commercial aviation, Civil Aeronautics Administrator James Pyle said last week.

Pyle told a House Legal and Monetary Affairs Subcommittee headed by Rep. John A. Blatnik (D.-Minn.) that "no easy solution" has been found to suppress jet noise without seriously affecting the power of the engine. He added that the National Advisory Committee for Aeronautics, "which has been hard at work on the fundamental technical aspects of this problem, is being urged to substantially increase its efforts in this direction."

He said that one engine manufacturer already has spent over $3 million and an airframe manufacturer over $10 million in efforts to develop an effective suppressor.

The Administrator also told the committee, which began hearings last week on jet transport problems, that claims from industry that suppressors on hand can lower the noise level of a jet transport to that of a piston-engine aircraft are "optimistic."

He added that "we are not at all sure this can be accomplished with our present knowledge of the problem."

CAA is studying a number of possible answers to the problem, including the use of preferential runways to allow aircraft to use runways and flight paths which would annoy the least number of persons and communities. Pyle said the use of ducted fan engines within the next five years should also help. He also told the committee:

- **Vortac navigation units** now being procured have been redesigned to eliminate many of the difficulties experienced with military equipment.
- **Expansion of air traffic** make a joint military-civil system of navigational aid necessary.
- **Federal Airways Plan** must maintain priority over Federal Airport Plan.

Airborne Vortac equipment (DME-T) has been developed to sell at an estimated cost of $5,000 to $6,000 for commercial aircraft, and manufacturers expect to offer models for general aviation use at $1,000, Pyle said. He added that CAA has no immediate plans to make the use of Vortac mandatory because of the high cost, but expects to do so around 1965.

Pyle said a symposium to demonstrate the use of Vortac will be held in October for the benefit of foreign countries. The International Civil Aviation Organization will discuss Vortac and the use of a common system at its February meeting in Montreal.

Top funding priority for the Federal Airways Plan is a necessity with CAA studies indicating 35 million itinerant operations by 1965 and 118 million revenue passengers a year by 1970, Pyle said. Necessary traffic equipment to cope with this volume means that federal aid to airports will have to remain secondary, he added.

CAA, which annually revises the National Airport Plan, has contracted with the University of California to conduct a study of commercial air route patterns and passenger potential which will result from the introduction of jet aircraft.

The agency also made a study of the airports where civil jets will initially operate as an aid in over-all planning and programming of federal funds related to the needs of airports. The study indicated Los Angeles, San Francisco, Seattle, Boston, New York and Baltimore will be among the first major terminals to handle jets during 1959.

French Cancel Bilateral

Washington—France last week renounced its bilateral air transport agreement with the U. S. because of failure to gain additional operating rights within the U. S. Agreement will be terminated in 12 months unless the two countries renegotiate the pact before then.

French government emphasized that termination of the agreement had no political significance and that the agreement was being dropped for commercial reasons only.

Air France has been dissatisfied within the bilateral agreement with the U. S. for over a year. The airline seeks a complete reciprocal exchange of routes with the U. S. and has insisted that Air France should be granted rights to serve all U. S. cities from which U. S. flag carriers operate into Paris.

Boeing 707 Makes Automatic Landing

Boeing 707 prototype made three successful automatic landings recently at Boeing Field, Seattle, using AN/GSN-5 system developed by Bell Aircraft Corp.'s Avionics Division for Navy and Air Force (AW March 4, 1957, p. 32). System employs ground radar to determine aircraft position and radio data link to transmit flare-out and course corrections to aircraft's flight instruments and automatic pilot. Prototype system will be evaluated in 1960 by Airways Modernization Board at its Atlantic City facility.

Nacelles Repositioned on Production Caravelle

Air France's first production Caravelle has logged more than 100 hr. in flight certification test program and incorporates several changes, including moving engine nacelles forward to improve center of gravity. Nacelles also have been lengthened and tailpipes of Rolls-Royce Avon turbojet engines have been angled to reduce dissymmetry of single-engine operation. Sud Aviation has extended dorsal fin along top of fuselage to house antenna. Air France has 24 Caravelles on order. Royal Air Maroc (Morocco) Airlines has ordered one Caravelle, has option on another. Sud has firm orders now for 45 Caravelles.

F-27 Costs Cause $5 Million Loss

Hagerstown, Md.—Difficulties in adapting foreign drawings of the Fokker Friendship to U.S. production methods resulted in unanticipated engineering and retooling costs and probably will cause Fairchild Engine and Airplane Corp. to lose money this year.

In a letter to stockholders, Richard S. Boutelle, president, said that the company expects a consolidated loss of $5 million for the first six months and, very probably, some additional losses for the last six months.

The report raised the question of whether the price of the airplane may be raised. No such plans are reported, but the question is under study.

Fairchild considers the price—about $600,000 for the basic airplane—as now falling in the bargain class.

According to Boutelle's letter:

". . . When the corporation attempted to adapt its heretofore successful production methods to the Dutch drawings and designs . . . it ran into unforeseeable delays and problems. This involved large expenditures for Fairchild engineering and tooling, in addition to costs incident to delays."

AVIATION WEEK learned that Fairchild encountered problems such as these:

• **Dutch drawings** were oriented to the European hand-built system. With master craftsmen available at relatively low cost, Dutch could cut and fit the airplane together by hand and needed less precision in drawings. Fairchild ran into trouble trying to build precision tooling for U.S. mass production which uses a minimum of hand work.

• **Drawings varied** among different stages of the design and finished parts sometimes failed to match. Fairchild might have waited for a complete set of one airplane drawings, but there was danger the airplane would then have appeared too late for American market.

• **Conversion** of measurements from metric to U.S. system caused additional labor.

• **Language barrier** hampered communications between the two companies.

Fairchild reported a first quarter loss of almost $2 million, but had predicted a profit by year end. Previously, total F-27 write-offs were estimated at $15-20 million. Last year the company wrote-off $8.7 million of this total.

Sales figures for the F-27 have tended to fluctuate because of the problems encountered by the prospective buyers, usually local service lines, in raising funds. Fairchild reports prospective buyers for 180 airplanes, but a large share of these are not firm.

Latest count for firm sales is 49—33 to U.S. carriers and 16 to foreign. This figure seems to approximate the amount specified in Fairchild's 1957 annual report where F-27 deposits are carried as a current liability under an item of "advances on commercial sales contracts."

This figure totaled $3,176,074. Assuming a 10% deposit on each airplane, it would account for about 50 airplanes.

Wall Street financial specialists say that the future of the F-27 is heavily dependent on the Guaranteed Loan. Thus far, Piedmont with eight airplanes and Bonanza with six have had such loans approved. West Coast Airlines is preparing to take delivery on the first of six F-27s ordered, but as of now has obtained no Guaranteed Loan.

Carmichael Resigns

Washington—J. H. (Slim) Carmichael, former president of Capital Airlines, resigned as board chairman and director last week "for personal reasons" after 29 years with the company.

Carmichael was named Capital president in 1947 and launched a broad scale program that pulled the carrier into a profitable operation after several years of extreme financial difficulties. He lost the presidency last year after Capital again slipped back into the red.

In a formal acceptance of his resignation, the airline's directors expressed "deep regret" and paid tribute to Carmichael for his significant contribution to the company. Carmichael made no announcement as to his future plans.

Carmichael was elevated to the position of board chairman last year when former USAF Maj. Gen. David Baker was elected to replace him as president and chief executive of the company (AW July 29, 1957, p. 39).

Board Proposes Pilot-Trained Engineers

By L. L. Doty

Washington—An emergency presidential board organized to try and settle the bitter controversy between airline pilots and flight engineers over crew complements recommended last week that third crew members on turbojet transports become pilot qualified.

Although the board's proposals are not legally binding on any party, such recommendations are seldom ignored and are expected to set a pattern for future negotiations by U.S. carriers. Under the board's recommendations, based on a dispute involving Eastern Air Lines, flight engineers would continue to serve on piston-engine and turboprop equipment without flight training and would be given an opportunity to qualify as pilots if assigned to turbojets.

The long-standing feud between the Air Line Pilots Assn. and Flight Engineers International Assn. on the third crew member issue has threatened a delay in the introduction of jet operations into scheduled service by U.S. carriers.

Why the Decision

In outlining its reasons for eliminating the engineers' position on turbojet aircraft, the board found that increased speeds and altitudes will introduce additional problems of a piloting nature while curtailing those of the mechanical nature.

It said that "what the pilots need is someone who can relieve them of some of their innumerable and important flying duties, with the purpose of not only making their workload more tolerable but, more important, of promoting safety."

The issue first came to a head in 1956 when the pilots union announced its decision to demand that all crew members on turbine-powered aircraft be qualified as pilots (AW Nov. 19, 1956, p. 39). Since then, the engineers have conducted a heated campaign to retain their status quo in the cockpit.

During the last year, the engineers have successfully signed contracts with Pan American, American and Trans World extending their job rights into jet operations. The contracts immediately drew a warning from the pilots that no jet transports would be flown by ALPA members unless at least three pilots are assigned to each aircraft with or without flight engineers (AW March 31, p. 34).

The board's report, which has been approved by President Eisenhower, does not constitute a settlement of the strike threats against Eastern. In January, both unions voted to strike but action was deferred by the creation of the emergency board through executive order of the President.

Now, both unions are required to negotiate with Eastern during the next 30 days after which they are free to strike if no settlement is reached.

The board's report is construed by most observers as a victory for the pilots union. However, ALPA President, C. N. Sayen, said in Chicago that the report calls for comprehensive study before determining the union's position on the recommendations. Sayen did imply some satisfaction with the report by adding that it "now becomes the recommendations of the President of the U.S. and, therefore, carries great weight and must be carefully considered."

Engineer Opposition

George R. Petty Jr., president of the flight engineers, promptly rejected the report by stating that "we will accept no findings on the crew complement issued by the board." He branded the report "incredible and foolish."

There is no doubt that the board's decision is a sharp blow to the flight engineers' union. The union has been strengthening its position for several years to meet the anticipated decline in cockpit jobs during the initial stages of jet transport operations.

Whether it will survive this setback will depend entirely upon its success in future negotiations with the airlines. Civil Aeronautics Board regulations governing flight engineer requirements permit either pilot-qualified or mechanic-qualified engineers so that the final decision as to crew qualifications rests with the airlines.

According to the emergency board report, Eastern officially maintained a "hands-off, neutral policy." With few exceptions, the carrier took no position over the merits of mechanical versus pilot-trained flight engineers, according to the board.

Some observers feel there is a strong chance that the engineers union, as a result of the decision, may swing from the AFL-CIO, of which ALPA is also an affiliate, to James Hoffa's International Brotherhood of Teamsters which recently announced it would try and unify labor within the transportation field.

Such a move would be the result of an earlier recommendation by the AFL-CIO that the Flight Engineers International Assn. merge with the Air Lines Pilots Assn. so that the flight crew would be "coordinated into one organization." ALPA has accepted this decision but FEIA has resisted it, not wishing to lose its identity as bargaining agent for the engineers.

In no way did the board spell an end to FEIA. One of its recommendations was that the flight engineers, acting through their union, enter into discussions "promptly" with ALPA members for the purpose of reaching an agreement on their respective contract seniority provisions. It urged that the two unions "jointly" approach Eastern as a means of working out the necessary revisions of these contracts.

The board stated that FEIA's fear of submersion is "not unique" and added that other small unions have found ways of safeguarding their interests to ensure adequate representation on governing bodies and negotiating committees.

The board's recommendations suggest that flight engineers who serve on turbojet aircraft be required to qualify as pilots to the extent of holding a commercial license and an instrument rating so that they would be capable of flying and landing the aircraft in case of emergency.

Flight engineers serving on piston engine aircraft and turboprop equipment would continue to do so without meeting pilot requirements.

Who Pays

The report said that "a flight engineer taking such pilot training will presumably do so on his own time, although at company expense." It added that if the engineer chooses to be trained as a pilot, his seniority on the engineer list should continue to accrue for sufficient time to assure him job protection.

The board placed primary considerations on safety and said that the bitter dispute between the pilots and engineers' union impinged upon the safety factor. It pointed out that the friction and antagonism between the two organizations has grown as a result of the crew complement issue.

The board emphasized that the role of flight engineer is that of "assistant to the pilot" and that the responsibility for the command of the aircraft rests with the captain. It noted that safety objectives sought by the Civil Aeronautics Board in 1948 when the flight engineer requirement was established has been substantially achieved with either pilot-qualified or mechanic-qualified engineers.

It added, however, that the friction between the two unions has a "tendency to preclude that degree of cooperation which is vital in operations as critical as that of flying airplanes in the air transportation industry."

Two boards were established by the

President, one to handle the ALPA issue and one the FEIA issue. However, both boards were composed of the same members. They were David L. Cole, chairman, Saul Wallen and Dudley E. Whiting. All three have a long record of mediating labor disputes.

The board was created in January and convened in New York on Feb. 11. The board requested and received from the President five 30-day extensions of the time specified in the executive order for the board to make its final report.

The board reported that it met with the parties jointly and separately in an effort to bring about settlement at the conclusion of hearings but added: "these efforts were not completely successful."

SHORTLINES

► **Condor Luftreederei GmbH.**, a West German charter airline, has purchased two Convair 440 Metropolitan airliners. Condor, based at Hamburg, will start flying as an independent charter carrier later this month, serving European travelers en route to Mediterranean and other tourist centers.

► **The Flying Tiger Line** reports that air freight revenues for the first half of 1958 were 10% higher than those for the same period of last year. Revenues of $5,278,567 were reported as compared to $4,756,778 for the first half of 1957. June air freight revenues were $905,180, a gain of 24% over the June, 1957, revenues of $731,599.

► **Real-Brazilian International Airliners** has transferred its U. S. headquarters from Miami to Chicago. In announcing the change, Captain Linneu Gomez, Real president, cited the "growth of both passenger and cargo traffic between Chicago and the expanding markets of South America" as the reason behind the transfer.

► **TSA-Transcontinental S. A.**, independent Argentine airline, is scheduled to begin international operations in mid-August with service between New York, Caracas, Rio de Janeiro, Sao Paulo and Buenos Aires. TSA will operate on a three flights per week schedule using Lockheed Super H Constellation aircraft. The airline has on order a $20 million fleet of Convair 880 jet airliners scheduled for delivery in 1960.

► **SAS, Scandinavian Airlines System,** reports that it carried 29,500 lb. of air freight on its polar route from Los Angeles to European points during June. This represents a 30% increase over the previous monthly record.

AIRLINE OBSERVER

► Airline common stocks listed on the New York Stock Exchange continued to hold close to 1958 highs last week although price gains fell short of those registered by the market generally. Strength of airline stocks was ascribed by some traders as a normal reaction to heavy buying of leading industrial shares following recent reports of favorable business developments and rising steel operations.

► **American Airlines has determined that descent of its 707 jet transports should begin about 120 nautical miles from the airport when no holding is involved. Desirable rate of descent for landing at maximum gross weight should be 1,000 ft. per minute at 300 knots indicated airspeed from 30,000 ft. to 28,000 ft. Thereafter, descent should be about 2,500 fpm. at an indicated airspeed of 335 knots.**

► Available seat miles offered by the domestic trunklines in June totaled 3.64 billion, an all-time high. However, percentage of increase during the month over June of last year was only 11.7%, the lowest rate of increase in this category recorded in recent years.

► **Lockheed Aircraft Service International, Inc., representatives are discussing with Mexican government officials a basic aviation program that may involve the construction of the first complete transport overhaul base in Latin America.**

► North Central Airlines has signed an agreement with Continental Air Lines for the purchase of five Convair 340 aircraft with delivery to begin in January. North Central plans to raise $3 million for the fleet through the sale of equipment trust certificates. An additional $2 million working capital loan is being worked out with Northwestern National Bank of Minneapolis and the Irving Trust Co. of New York.

► **Chicago Helicopter Airways is drawing close to its goal of topping 100,000 passengers for the year. During the first six months of 1958, the airline carried 47,862 passengers as compared with 15,471 for the same period last year.**

► East Germany's civil jet transport plane, the Baade BB-152 (AW May 26, p. 42), is scheduled to begin flight tests in August.

► **American Airlines is conducting a six-stage training program for Boeing 707 jet transport pilots. The program, involving a total cost of approximately $2.5 million, includes a home study familiarization course, ground school, flight simulator, in-flight training, company specialized training and first scheduled flights with observers.**

► Aquila Airways, one of Britain's independent airlines, will cease operations Sept. 30. The company, a subsidiary of Peninsular and Oriental Steam Navigation Co., has operated Solent flying boats between Britain and Lisbon and Madeira.

► **KLM Royal Dutch Airlines and the Soviet airline, Aeroflot, last week began direct weekly service between Moscow and Amsterdam under the terms of a recently signed bilateral agreement between Russia and the Netherlands.**

► Civil Aeronautics Board last week authorized Continental Airlines to fly nonstop between Dallas-Fort Worth and Midland-Odessa, Abilene, Amarillo, Lubbock, El Paso, Albuquerque and Santa Fe. Trans Texas was authorized to fly nonstop between Dallas-Fort Worth and San Angelo, Texas. The authorizations were voted tentatively in the Dallas to the West Coast Case.

► **Air Traffic Conference decision to eliminate the $3.00 penalty clause of the noshow control plan on August 12 and to drop the reconfirmation ruling on Dec. 1 has been approved by the Civil Aeronautics Board. Chances are now strong that the conference will agree to a noshow program similar in context to American Airlines' verification plan (AW July 21, p. 29).**

Airline Traffic—May, 1958

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	662,000	414,111	62.0	1,751,729	742,390	7,093,206	49,392,674	52.7
Braniff	176,933	72,722	56.4	316,841	148,931	572,765	8,220,412	46.9
Capital	329,305	131,565	52.8	586,078	276,299	366,349	13,830,720	43.3
Continental	65,572	29,939	44.8	108,853	61,169	163,044	3,211,778	37.8
Delta	223,585	110,321	55.2	418,214	242,184	1,019,029	12,296,043	50.9
Eastern	618,293	323,123	49.29	936,816	428,548	1,143,060	33,630,054	45.16
National	107,040	64,656	51.7	265,840	39,276	522,387	7,104,113	44.5
Northeast	67,439	27,453	41.9	65,356	26,836	99,800	2,819,622	35.3
Northwest	124,991	86,252	46.5	493,551	212,605	841,490	9,825,126	41.8
Trans World	383,932	306,221	60.1	1,162,520	567,487	2,078,306	33,141,612	53.5
United	568,180	403,669	61.9	2,516,296	804,393	5,196,393	47,339,812	55.3
Western†	256	60	51.3	.....	.....	.....	5,715	44.3
INTERNATIONAL								
American	8,451	7,145	36.7	8,775	310	306,533	1,068,575	44.3
Braniff	3,611	6,693	43.1	11,030	.....	94,435	841,042	39.5
Caribbean-Atlantic	18,191	1,253	53.6	1,876	.....	3,062	135,433	58.5
Delta	4,346	5,794	47.1	7,887	.....	52,738	704,634	42.1
Eastern	28,287	37,864	46.30	88,708	.....	98,841	4,096,377	47.21
Mackey	6,313	1,150	36.0	.....	.....	1,416	126,066	37.9
National	4,594	3,309	38.0	9,328	4,264	39,244	404,944	35.4
Northwest	12,009	25,770	50.3	1,104,176	17,541	723,634	4,590,768	61.6
Pan American								
Alaska	3,839	4,178	62.8	30,816	.....	169,256	619,541	57.4
Atlantic	106,250	142,387	58.1	1,204,682	.....	2,134,100	18,240,836	55.2
Latin America	78,977	87,300	55.8	390,802	.....	4,244,967	13,200,161	58.6
Pacific	20,669	75,324	68.0	1,084,261	.....	1,333,137	10,314,365	64.9
Panagra	10,712	13,464	51.0	70,693	.....	459,282	2,010,853	55.9
Resort	.....	.....	....	.....	.....	3,778,587	3,778,587	77.2
Trans-Caribbean	13,737	1,915	54.7	748	.....	8,460	162,893	54.8
Trans World	29,854	80,055	51.1	962,160	.....	629,341	9,974,732	51.5
UMCA‡	154	51	37.0	.....	.....	1,893	7,586	53.4
United	7,643	18,986	60.4	145,494	.....	91,808	2,180,276	60.0
Western†	247	384	65.0	.....	.....	.....	41,289	68.5
LOCAL SERVICE								
Allegheny	39,473	6,904	45.7	9,728	17,521	17,563	703,963	45.6
Bonanza	15,955	3,715	46.4	4,816	2,946	8,811	371,098	44.5
Central	11,192	2,107	34.1	4,903	2,187	7,180	216,458	30.6
Frontier*	.....	.....	....	.....	.....	.....	.....	....
Lake Central	14,503	2,307	36.4	3,304	12,518	.....	236,340	38.6
Mohawk	39,036	7,309	48.3	6,416	14,750	12,885	731,507	48.4
North Central	60,050	10,226	44.6	23,583	30,426	.....	1,034,989	45.1
Ozark	35,994	5,988	43.7	10,960	15,676	13,651	612,824	45.4
Pacific	32,164	7,245	54.5	11,253	5,765	6,834	714,937	52.4
Piedmont	34,239	7,062	49.0	14,885	9,650	14,855	716,636	48.8
Southern	17,838	3,250	36.0	8,557	8,103	6,431	334,720	36.0
Trans-Texas	19,011	4,371	36.1	13,783	7,590	27,682	467,601	37.1
West Coast	22,180	3,814	45.37	4,990	3,170	8,780	381,131	43.48
HAWAIIAN								
Hawaiian	28,712	4,358	60.2	5,646	.....	132,692	488,636	55.9
Trans-Pacific*	.....	.....	....	.....	.....	.....	.....	....
CARGO LINES								
AAXICO	.....	.....	....	5,158	10,843	3,475,551	3,491,552	82.99
Aerovias Sud Americana	.....	.....	....	.....	.....	567,797	567,797	85.2
Flying Tiger*	.....	.....	....	.....	.....	.....	.....	....
Riddle*	.....	.....	....	.....	.....	.....	.....	....
Seaboard & Western	7,937	30,304	100.0	3,862	.....	1,259,632	4,298,787	80.3
Slick*	.....	.....	....	.....	.....	.....	.....	....
HELICOPTER LINES								
Chicago Helicopter	9,746	181	40.2	1,737	.....	.....	18,968	32.4
Los Angeles Airways	3,617	110	51.9	4,671	1,813	.....	16,987	59.3
New York Airways	6,336	119	40.5	1,422	788	480	14,034	41.6
ALASKA LINES								
Alaska Airlines	5,550	2,963	36.3	50,239	.....	262,849	618,506	42.3
Alaska Coastal	52,594	4,715	63.9	47,799	.....	50,836	576,863	65.0
Cordova	1,414	137	34.4	4,257	.....	8,703	27,295	41.9
Ellis	4,660	327	61.0	1,732	.....	3,016	38,249	73.05
Northern Consolidated	1,724	553	42.5	27,227	.....	51,097	138,442	55.6
Pacific Northern	9,977	9,230	53.2	95,383	4,637	267,585	1,370,488	62.8
Reeve Aleutian	1,116	701	31.3	20,758	.....	82,067	179,859	54.3
Wien Alaska	1,991	743	25.1	37,041	.....	212,291	325,604	58.8

* Not available. † Western strike 2/21/58 to 6/1/58. ‡ Uaba, Medelin & Central Airways.

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This motor, of advanced design, for various applications in missiles is only 3-15/16" x 3-15/16" x 7¼" in size, with the exception of mounting provisions and terminals, yet delivers 9½ HP intermittently @ 17,000 rpm. on 56 volts DC. It is designed without an output bearing so that it may be made an integral part of a pump, blower, compressor or other missile component. Type D-1026 will withstand an overspeed condition of no load and 66 volts terminal voltage. It is totally enclosed, explosion proof, and built for excessively high shock and vibration requirements.

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Specifications

FOR EEMCO MOTOR TYPE D-1026

Output: 9½ HP @ 17,000 rpm intermittent duty

Volts: 56 volts DC

Weight: 12¼ lbs.

Dimensions: 3-15/16" x 3-15/16" x 7¼" (excluding mounting provisions and terminals)

Overspeed: Will withstand 66 volts terminal voltage and no load.

Features: Small size; advanced design; is totally enclosed, explosion proof, built for extreme shock and vibration requirements.

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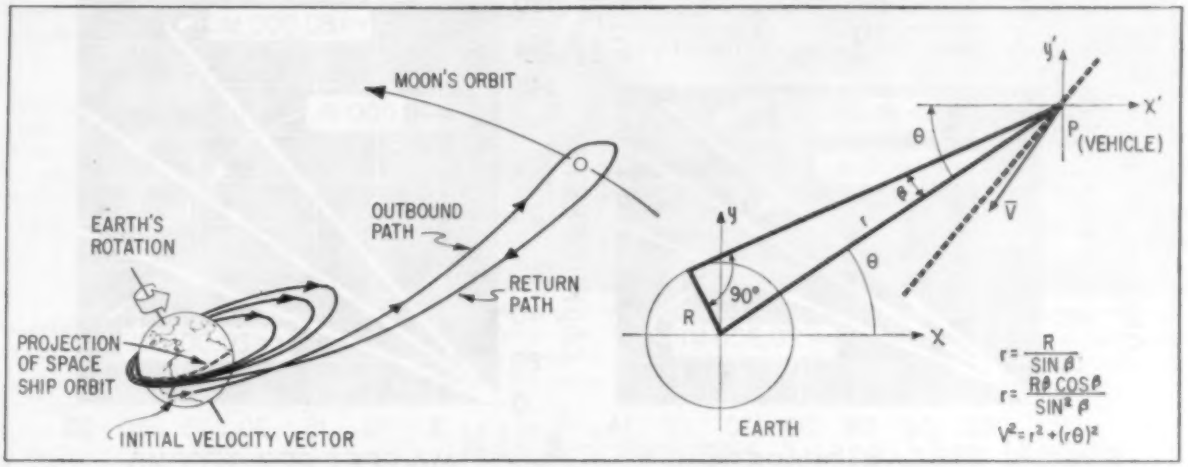
PIONEERS IN TURBINE POWERED HELICOPTERS



BRAKING ellipse approach to recapture of a circumlunar probe (left) saves weight of retro-rocket fuel but requires precise knowledge of velocity vector. Technique for measuring vector and direction (right) by optical and computer means has been proposed by WADC.

WADC Explores Lunar Probe Control

Dayton—Novel technique for determining velocity vector magnitude and direction of a circumlunar probe vehicle has come out of a recent study by Wright Air Development Center's Flight Control Laboratory.

Wright Air Development Center's analysis, made by a team of Flight Control Laboratory engineers headed by George Xenakis, also points up some of the precision control problems involved in recapture of a lunar probe vehicle by means of a braking ellipse approach in which the vehicle slowly spirals into a circular orbit as a result of atmospheric drag.

Braking ellipse approach requires extremely precise control of the vehicle injection angle or velocity at launch as well as injection altitude as the vehicle enters the earth's atmosphere on its return leg. However, this technique requires vastly less fuel, hence far lower vehicle gross weight, than use of retro-rockets to decelerate vehicle.

Precision Return

For example, assuming that initial launching velocity vector for a 15,000 lb. payload can be controlled to within 0.001 deg. or 1.0 fps., WADC's analysis indicates that approximately 300 lb. of fuel would suffice to correct for space disturbances encountered en route, and could bring a vehicle back with acceptable precision to permit braking ellipse approach.

By contrast, use of retro-rockets to slow down a vehicle from 36,000 fps. to an orbiting speed of 25,000 fps. would require an estimated 60,000 lb. of fuel, increasing vehicle gross weight by a factor of four, the analysis indicates.

Braking ellipse approach requires a means for accurately determining the vehicle's velocity vector (speed and direction) relative to earth on the return leg. Xenakis proposes a simple technique which requires only a stellar fixed inertial reference system within the vehicle and instrumentation for measuring angles and angular rates. Further analysis is needed to determine whether the extremely small angular rates involved can be measured to the required accuracy, Xenakis concedes.

Principles behind the proposed velocity control system are the following:

Assume a set of orthogonal axes, X′ and Y′, centered in the space vehicle and oriented arbitrarily in the plane of the vehicle's motion. A similar set of axes, "X" and "Y", is assumed to be centered at the earth's center and aligned parallel to corresponding axes in the space vehicle.

Radial distance between vehicle and earth's center is:

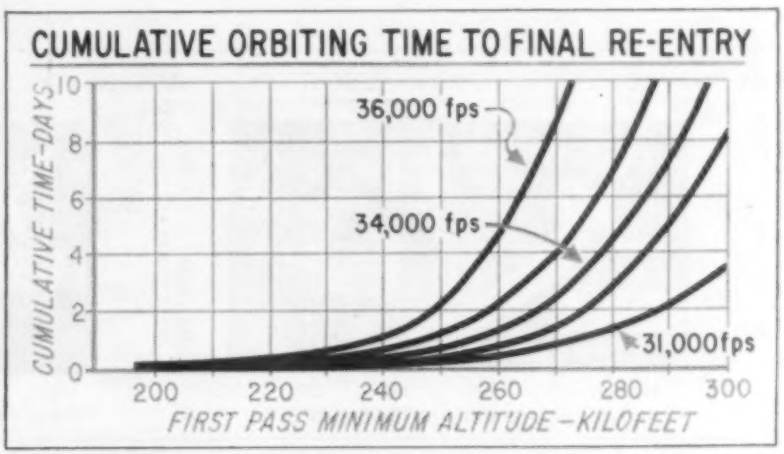
$$r = \frac{R}{\text{Sin } B}$$

Where: r is radial distance
R is earth's radius (assuming spherical earth)
B is angle defined by lines connecting vehicle with center of earth and its outer edge.

Radial component of vehicle's velocity is:

$$\dot{r} = \frac{R\,\dot{B}\,\text{Cos } B}{\text{Sin}^2 B}$$

After suitable trigonometric manipu-



RECAPTURE orbiting time using brake ellipse is shown as function of first-pass altitude.

slows down sufficiently to go into circular orbit where it remains entirely in the earth's atmosphere.

For example, Wright Air Development Center's analysis shows that a vehicle with low mass-drag ratio

$$\left(\frac{W}{C_D A} = 100 \text{ psf.}\right)$$

which first enters the earth's atmosphere at a velocity of 36,000 fps. and at an altitude of 270,000 ft., will orbit for approximately nine days before reentry into a circular orbit entirely within the earth's atmosphere. However, if the initial pass is made at 220,000 ft., recapture time would drop to only 10 hr.

Deceleration Forces

Although low-altitude first-pass, with attendant short recapture period has obvious advantages, peak deceleration forces and vehicle temperature increase as the first-pass altitude is decreased.

For example, at 36,000 fps. velocity and 220,000 ft. first-pass altitude, a vehicle will experience deceleration of of 1.6G, compared to only 0.2G at 270,000 ft., the analysis shows. Maximum equilibrium wall temperature during recapture would be approximately 2,800F at 220,000 ft., compared with only 1,900F at 270,000 ft. Temperature figures were calculated on the assumption of zero lift, laminar flow and emisivity of 0.5.

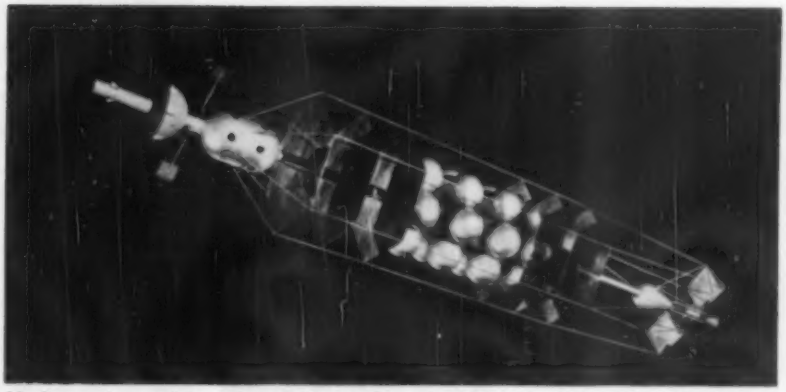
Selection of optimum first-pass altitude therefore requires a suitable compromise between minimum recapture time and minimum G-forces and heating.

Required Accuracy

Once the desired intercept altitude has been selected, a question arises as to how accurately the vehicle's velocity vector (direction and amplitude) must be known to approach desired first-pass altitude. WADC's analysis indicates that:

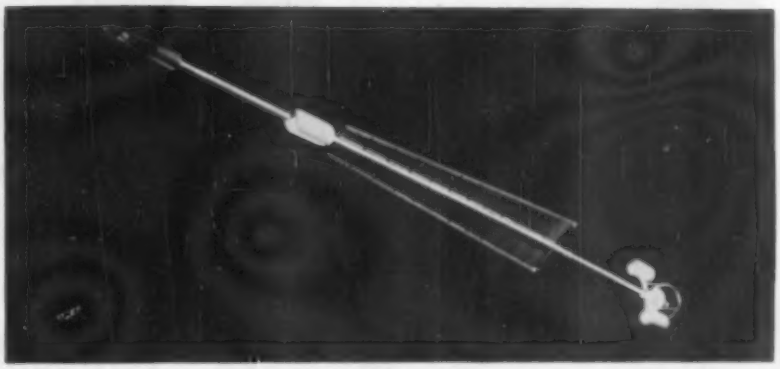
- **Error of 0.01 deg.** in measuring velocity vector direction at distance of 80,000 mi. from earth can result in an error of 40,000 ft., in first-pass altitude, or an error of 20,000 ft. if measured 20,000 mi. out.
- **Error of 5 fps.** in measuring velocity magnitude at distance of 80,000 mi. results in 30,000 ft. error in achieving first-pass altitude, or 10,000 ft. error when measured while vehicle is 20,000 mi. out.

Thus an error of 0.01 deg. in velocity vector direction, measured in a vehicle traveling at 36,000 fps. while it is 20,000 mi. away from the earth, could increase recapture orbiting time by a factor of five, i.e. from one day to five days. This points up the extreme accuracy in velocity vector measurement which is required to make braking ellipse approach feasible.

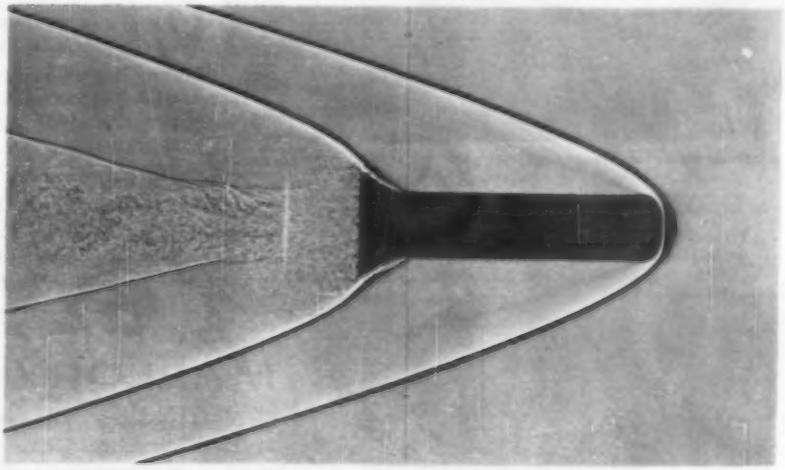


Nuclear rocket model consists of (from extreme left) landing vehicle and cabin, clustered hydrogen storage tanks between solar shields, and nuclear rocket engine (at right end). NACA says models show the basic components of an electrical propulsion system but emphasizes they are not intended to be representative of a prototype space craft.

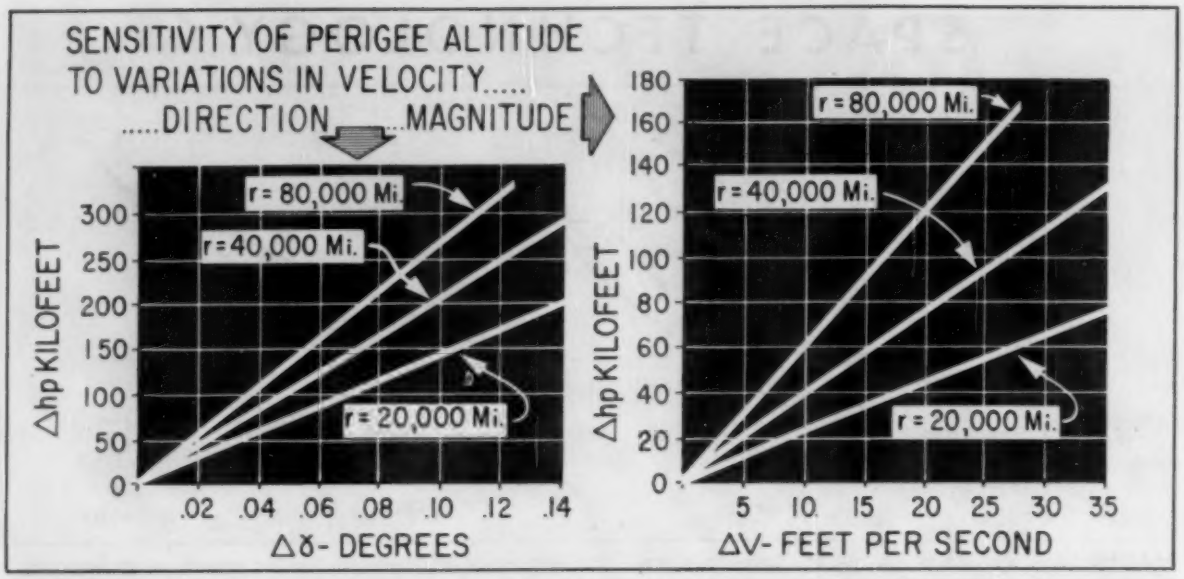
NACA Envisions Space Ship Design



Model of future space ship was set up by NACA scientists at Ames Aeronautical Laboratory to show components of electrical propulsion system. From tip to tail: nuclear reactor (at tip), followed by neutron shield, heat exchanger, gamma ray shield, propellant, turbo-generator (cylinder near middle), long radiator, and, at the tail, two crew cabins, landing vehicle and ring-shaped propellant accelerator. Working fluid from heat exchanger is circulated through the radiator and excess heat then is dissipated into space.



Mach 7 shadowgraph of gun-launched cylinder shows strong shock waves generated by blunt nose and flared skirt. The skirt is used to give vehicle stability. Shadowgraph was made in supersonic free flight wind tunnel at Ames Aeronautical Laboratory.



ERRORS in obtaining desired first-pass altitude as function of error in measuring direction of vehicle's velocity vector.

lation, vehicle velocity with respect to earth's coordinates (X, Y) can be expressed as:

$$V_x = -r\dot{\theta}\sin\theta + \dot{r}\cos\theta$$
$$V_y = r\dot{\theta}\cos\theta + \dot{r}\sin\theta.$$

Magnitude of vehicle velocity is expressed by:

$$V = \sqrt{\dot{r}^2 + (r\dot{\theta})^2}.$$

System Configuration

To utilize this technique, the vehicle will require a system containing up to three star trackers for obtaining celestial fixes to maintain orientation of reference coordinate system (X′ and Y′ axes). Absolute orientation of coordinate system is immaterial so long as it does not rotate with respect to inertial space.

Gyros would be used for short-term stabilization and would be corrected periodically by star sights.

Optical means would be used to establish a line to the earth's center and outer edge, to measure angle B, and to measure angle θ relative to coordinate system.

Rate of change of these angles, required for velocity vector computation, might be obtained using rate gyros or by differentiation of angle measurements. Relatively simple computer can then perform required trigonometric calculations to establish velocity vector information.

Xenakis emphasizes that this technique is based on a number of assumptions which must be analyzed quantitatively to determine their possible effect on over-all accuracy:

• **Oblateness:** Earth is an oblate spheroid and not a perfect sphere, which will introduce some error.

• **Out-of-orbit motion:** Technique assumes vehicle motion only in plane of its orbit, neglects the effect of possible perturbations normal to this plane.

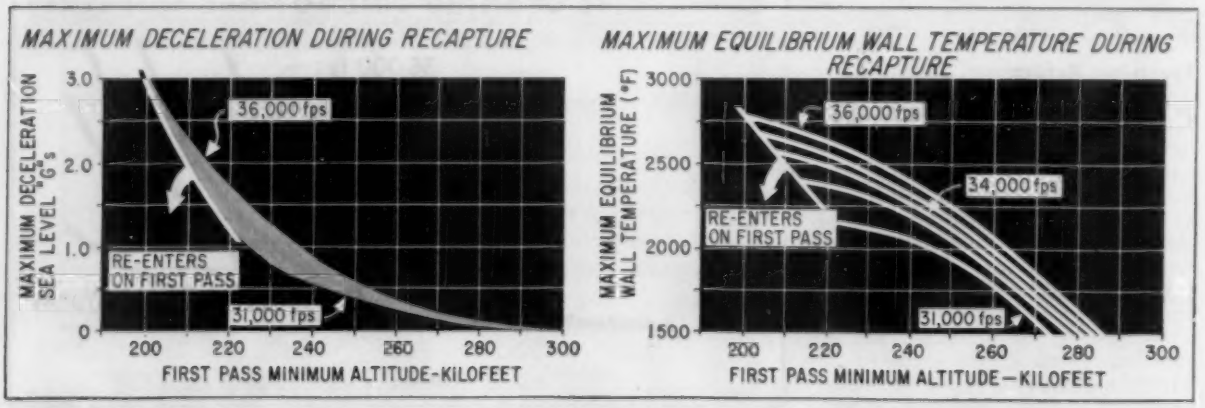
• **Optical errors:** Technique does not take account of possible errors arising from refraction due to earth's atmosphere.

• **Other bodies:** Effect of nearby celestial bodies is assumed to be negligible.

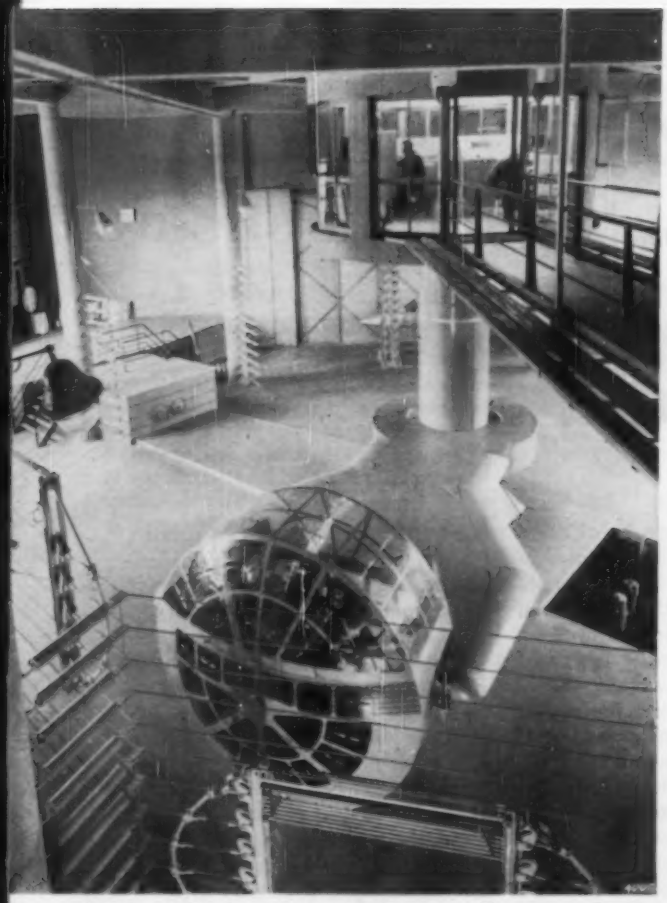
If subsequent detailed analysis of these and instrumentation errors indicates that the technique is not sufficiently accurate for braking ellipse approach, it may prove suitable for use with retro-rocket braking which requires less accuracy, Xenakis says:

Atmospheric Braking

The altitude (air density) and velocity at which the circumlunar vehicle initially intercepts the earth's atmosphere, for any given vehicle configuration, determines the total time spent in elliptical orbiting before the vehicle



MAXIMUM equilibrium temperature during braking ellipse recapture as function of first-pass altitude.



Interior of the new French Air Force centrifuge room showing centrifuge equipped with human gondola.

New French Centrifuge Has 15G Initial Acceleration

Bretigny, France—French Air Force Physiological Research Center has begun space flight research using a high-start centrifuge as a basic piece of equipment.

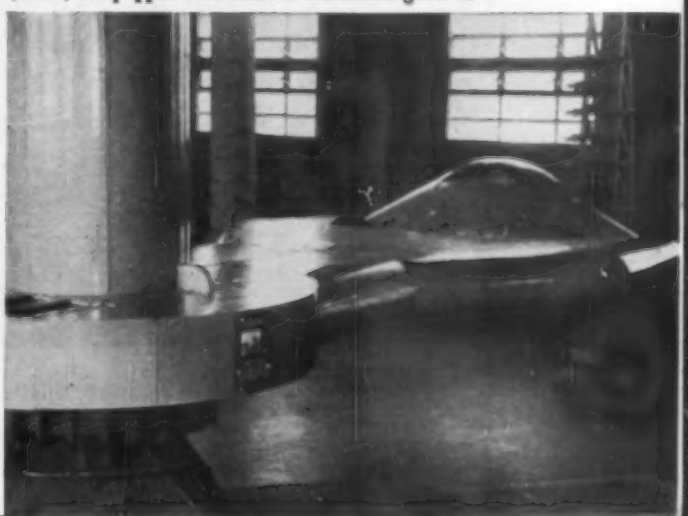
Centrifuge is said to be capable of 15G initial acceleration and a maximum of 40G by using a shorter radius arm and less mass. Initial acceleration system consists of a piston driven by compressed air charge which unwinds a cable wrapped around base of centrifuge vertical axis. Action imparts a high initial acceleration and geared motor then engages for higher accelerated rotation. Power is furnished by a 455 hp. motor that turns a 19½ ft. arm up to 77 rpm. or approximately 110 mph. Total weight of arm is about 11 tons with a 716 lb. counterweight.

Unlike the U. S. Navy's Johnsville, Pa., centrifuge (AW Mar. 24, p. 38), the French pilot gondola does not have a built-in control system to overcome subject's passive response. Control room for the centrifuge is located between the roof and the upper end of the vertical axis. Latter terminates in the center of the control room floor for maintenance access. Interior of control room contains surveillance television, gondola and arm operator communication equipment, visual response light panel and Dynograph for cardiology purposes.

Centrifuge arm incorporates a TV relay station and a forked end that adapts to two different gondolas: one for animal and material studies and the other for human subjects. Latter can be positioned on its roll axis to obtain negative or positive gravity forces. Interchange of gondolas is accomplished through use of an overhead electrically driven hoist controlled from ground level.

Large case in upper left of gondola is visual response light panel.

TV set monitors subject during tests (above). Centrifuge arm (below) is equipped with material and animal gondola.



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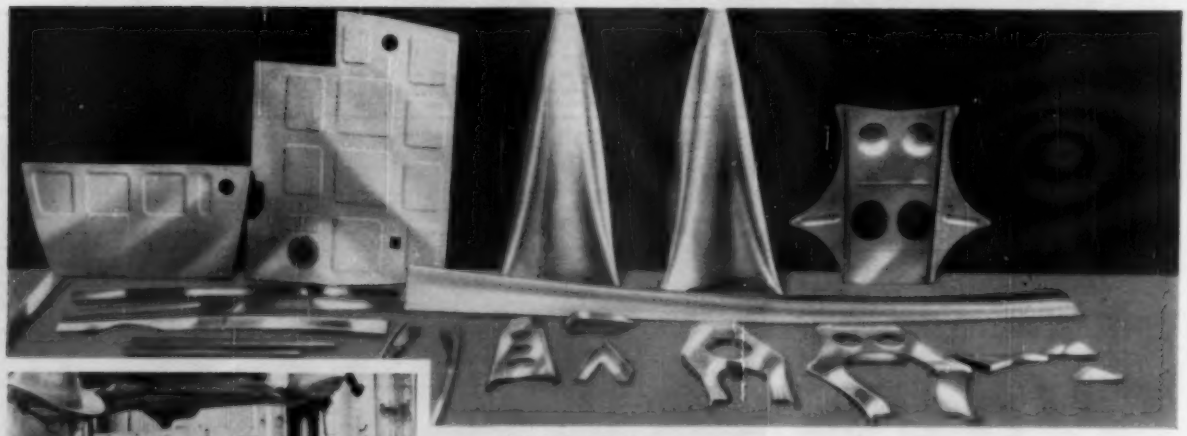
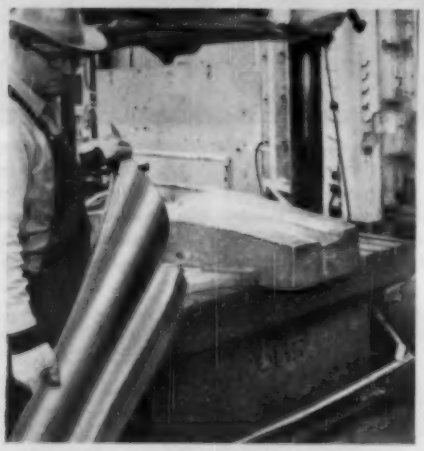
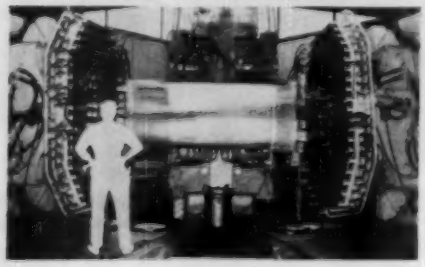


Fabricated Parts
Typical titanium parts fabricated by Rohr Aircraft for aircraft applications.



Drop Hammer Forging—*Oven-heated to 1000° F., commercially pure titanium parts are forged on cold drop hammer dies.*

Stretch Forming—*Titanium sheet is stretch-formed on this huge machine, using electrically heated dies, at Rohr's Chula Vista plant.*



Any doubt in your mind as to titanium's versatility and adaptability for forming and fabrication? Then check these examples from Rohr Aircraft Corporation, Chula Vista, California.

Rohr is a major manufacturer of aircraft parts and airframe components. It uses Mallory-Sharon commercially pure titanium and titanium alloys for many of its forged and fabricated parts . . . takes full advantage of the material's workability, as well as its high strength-to-weight ratio, excellent corrosion resistance and high temperature properties.

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On-Site Loading Proposed for Big Solids

By Michael Yaffee

Huntsville, Ala.—Taking a cue from established liquid propellant procedure, Thiokol Chemical Corp. is proposing on-site loading as a solution to the problem of transporting very large and heavy solid propellant vehicles. The suggestion was recently set before the Defense Department in detail.

Although the problem does not actually exist yet, many manufacturers and logisticians are convinced that now is the time to start worrying about possible solutions. The first 10,000-lb. solid propellant engine has already been built and static fired. Serious thought is being given to a solid propellant missile weighing several hundred thousand pounds and more than 200 ft. long—much too big for ordinary-sized thoroughfares and means of transportation.

To get around this difficulty, William F. Haite, chief of process development at Thiokol's Redstone Division, has developed plans for a mobile propellant loading plant. Like today's large liquid propellant rockets, the solid propellant missile would be carried unloaded and, if need be, disassembled to the launching area, where it would be erected in place and then loaded with pre-mixed solid propellant.

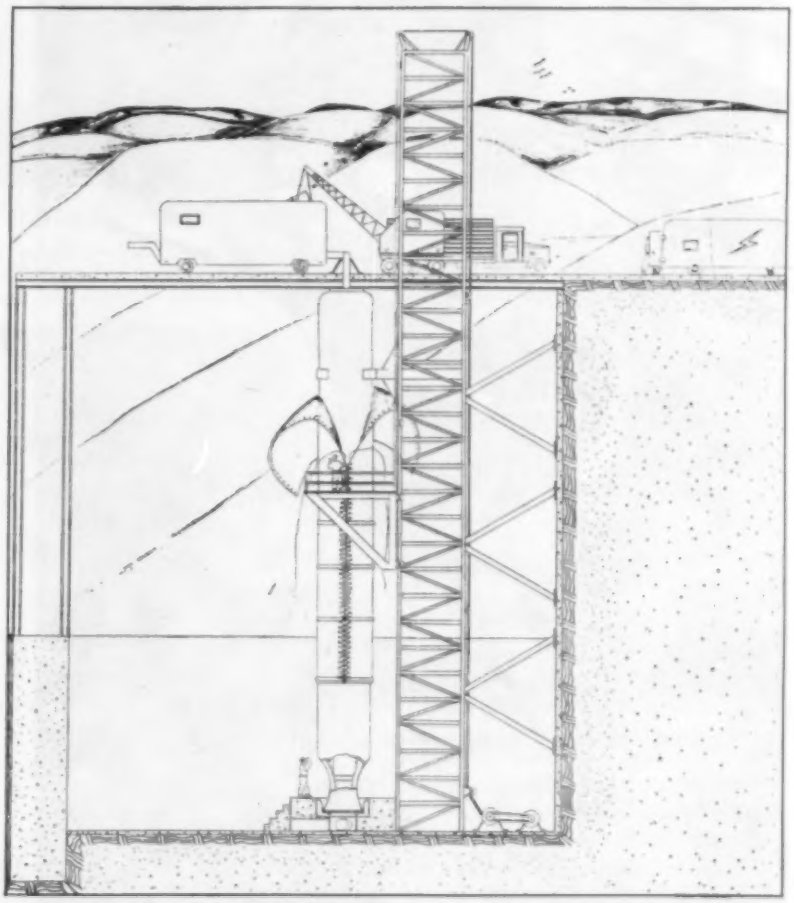
Site Problems

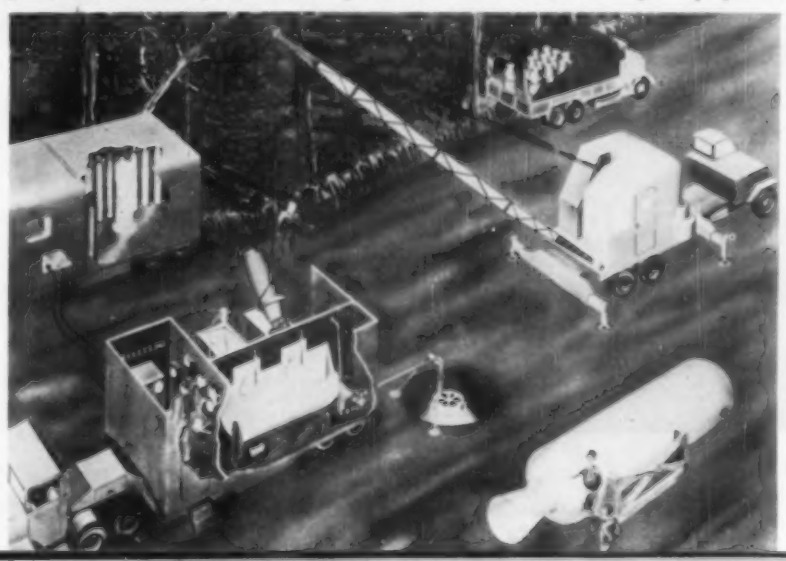
Assembly and erection of the empty missile casing can be carried out with techniques now used in the construction of large tanks and will present no problems, according to Haite. The selection of suitable launching sites, on the other hand, could prove difficult.

Successful operation hinges heavily on having access to the top of the empty, upright missile shell, several hundred feet high. Setting up a conventional launching complex this large would undoubtedly prove difficult and expensive. One way out is through the selection of locations that are partially surrounded by sheer cliffs of the required height.

Another and more likely solution is the use of abandoned mine shafts, or pits, specially prepared.

Once the missile casing is in place, trucks or trains would arrive carrying the propellant in positive discharging containers. Premixed at some manufacturing plant, the propellant would be in the form of paste or slurry, containing both oxidizer and fuel elements. A mobile crane would lift the containers from the transport carrier and dump





MOBILITY is key to proposed system for on-site loading of solid propellant missiles, weighing up to several hundred thousand pounds. Applications shown are for smaller units, but operational sequence is the same: crane carries propellant from truck to blender, where it is mixed with catalyst and then pumped into top of missile. The worker on the gantry (above) is lacing on the heating blanket which is used in curing the propellant.

PROP-JET GIANT SWALLOWS 35,000 POUNDS IN 40 SECONDS

Feats of Hercules, No. 4

The mighty 4-engine Lockheed HERCULES—America's first Jet Age airfreighter – performs cargo-handling feats no other plane can equal. Press a button and down comes the hydraulically-operated tail gate of the HERCULES, to loading dock height—leaving a cavernous aft cargo opening that measures 9 feet by 10 feet. In seconds, attendants attach a winch cable to loaded tandem-hitched pallets, in readiness on the dock. Press another button and 35,000 pounds of cargo glide inside the HERCULES—*in only 40 seconds!*

Airborne, the HERCULES climbs 2,450 feet per minute, fully loaded, and cruises at 305 knots. Arriving at its destination, this prop-jet giant can land and stop within 1500 feet—saving extra minutes of precious time. Highly maneuverable, it can be positioned quickly for unloading. Attach the winch cable, press a button —and out glides the whole 35,000-pound cargo *in 40 seconds!*

If *you* haven't yet heard all the facts about the time-and-dollar-saving capabilities* of the HERCULES Jet Age airfreighter, please write or wire

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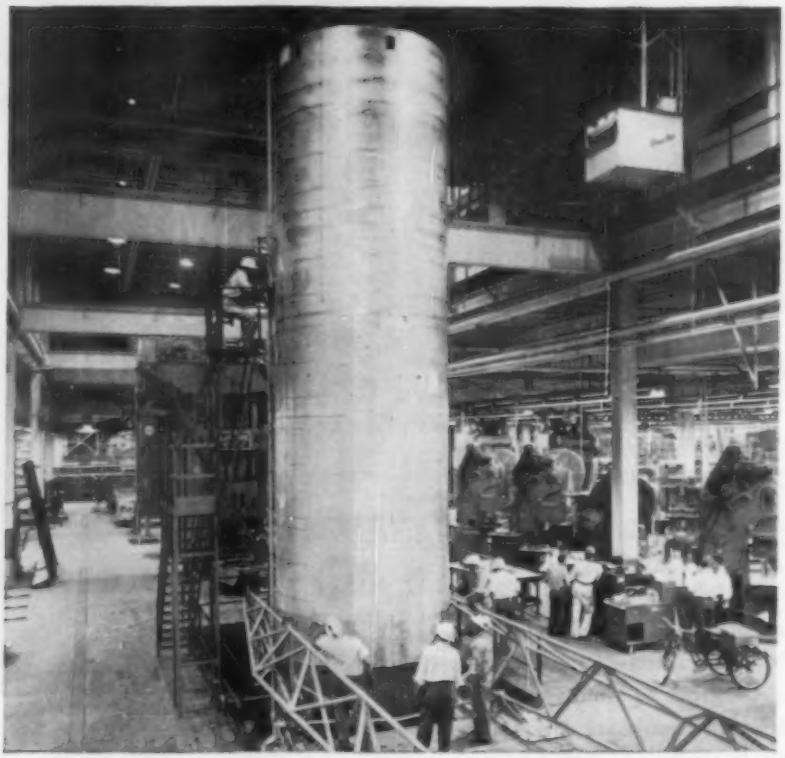
Parallel Missile Production Lines

Jupiter and Redstone ballistic missiles are in production on parallel lines (above) at Chrysler-operated U. S. Army Michigan Missile Plant near Detroit. Jupiter booster assembly (below) undergoes in-plant test. Heavy presses can be seen in background.



it the advantage in safety compared with a large, fixed site, propellant loading plant which would be more vulnerable to bombings or sabotage. If the mobile unit were knocked out, the damage to the over-all military effort would be less. On the other hand, system does encumber the solid propellant missile with unaccustomed ground support equipment, even though it is for a short time. Relative lack of such equipment has long been an advantage cited by the solid propellant advocates.

This is strictly a preliminary type of operation that would ordinarily take place in a plant, the solid advocates reply, and once the missile is loaded it is in the same ready state as current solid propellant vehicles, unburdened by propellant support units and with no need for countdowns.

In any event, this is considered of secondary importance. The important thing is that when solid vehicles get this big—and many engineers are convinced they soon will—they cannot be handled by conventional means.

Various details of this proposal suggest its application to the Minuteman project, but to date on-site loading is still a Thiokol project with no government support.

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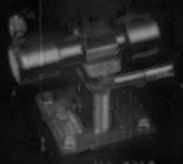

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them into a mobile blending unit.

To speed up the process, the blender may be a dual cycle unit wherein one batch is blending and discharging while the second is being poured. If required, more than one blender could be used. A mobile van would supply the power required to operate the blender and to maintain temperature control. The van also carries the catalyst used to set up (i.e., harden) the propellant.

In the blender, the pre-mixed propellant fractions would be mixed with the catalyst, derated, and, still fluid, pumped into the top of the missile. The propellant would start to set soon after entering the missile casing. A heating blanket, wrapped around the casing earlier, would be used in the curing and finishing of the cast grain.

After final inspection, the igniter would be inserted, the top cap welded on, and the missile would be ready to go. The whole operation would take from a few hours to several days, depending upon the size of the missile, and would be largely automatic. The job finished, the mobile vans could move on to another site.

In the case of a multi-staged missile, the operation would be essentially the same, except that after the first unit is loaded, the second stage is dropped into the shaft and attached in place of the cap.

The process is then repeated as many times as there are stages. Although the system was developed primarily for large, single stage units, it would work as well for multi-staged missiles or smaller single-staged vehicles.

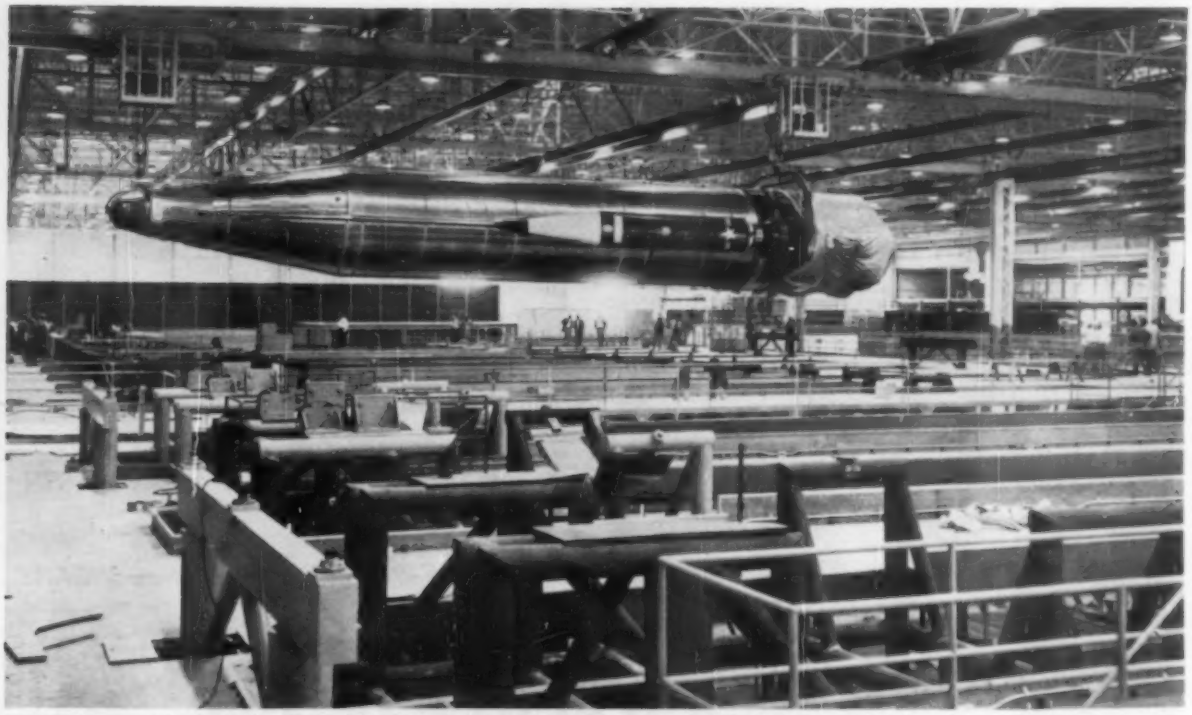
The mobility of the system also gives

Five-Stage Rocket Firing

Economical five-stage rockets composed of off-the-shelf engines have been fired at speeds above Mach 16 and to altitudes of several hundreds miles in research on missiles and spacecraft, National Advisory Committee for Aeronautics reported.

Five-stage rocket consists of an Honest John, two Nike boosters, a Recruit and a T-55 and is an extension of a research technique pioneered by NACA in 1945. Horizontal boost-glide aircraft trajectories are simulated by firing the last three stages in rapid succession just after vehicle passes peak trajectory.

Similar rocket, called Jason and using the same five stages, is being used in Operation Hardtack to measure radiation patterns and other effects of out-of-atmosphere nuclear blasts (AW July 7, p. 26). NACA version is 55 ft. long, weighs 7,000 lb. and carries 30 lb. payload. Firings have been from Langley Aeronautical Laboratory's Pilotless Aircraft Research Station, Wallops Island, Va.



OVERHEAD crane hauls an Air Force Atlas intercontinental ballistic missile across the high bay area in factory area of Convair Astronautics Division new plant at San Diego, Calif. Picture was taken while installation of tooling was under way.

Astronautics Plant Gears to Space Role

San Diego—Astronautics Division of Convair dedicated its new Kearny Mesa facility recently, a $40 million establishment designed and geared to conception and production of Atlas intercontinental ballistic missile and the space vehicles which will follow.

Philosophy behind the Astronautic layout was dictated by the plant's mission, (AW May 20, 1957, p. 52), and was carried out by architect-engineer firm of Pereira & Luckman. McNeil Construction Co. held prime construction contract, cost of which approximated $20 million, and funds were supplied by Convair. USAF has approximately another $10 million in tooling and some test facilities.

Convair Commended

Principal speaker at the dedication ceremonies was Dr. Hugh L. Dryden, Director of National Advisory Committee for Aeronautics, who commended Convair for its work in manned aircraft as well as its efforts, including investment of its own funds, in missile projects such as MX-774.

Dryden emphasized that with space travel now coming to the fore, and with the magnitude and complexity of problems involved, a national space program will have to be formulated which will have fullest support of the American people, government administration and Congress.

In its role as a research agency, NACA currently has a large proportion of its facilities and personnel working on space flight problems, Dr. Dryden said.

While much basic research and development can be accomplished by agencies such as NACA, Dr. Dryden said he believes it still will be the job of industry teams to design and construct the space vehicles themselves for each application, such as is being done now in the Dyna-Soar program.

Dr. Dryden added that while the new National Advisory Space Agency, which is to be built around NACA, could undoubtedly eventually recruit the talent and build the facilities to do all the work involved under its title, the time and financial outlay required would be out of line. Instead, he said, he feels that NACA very effectively can contract with existing organizations which have trained scientific teams and facilities, to accomplish the required work.

New types of engines are needed, Dr. Dryden said, for space flight, and new sources must be developed for internal power during flight. Although design and development of very large thrust chambers on the order of a million pounds of thrust is being initiated now, it is not necessary that the U.S. wait until these propulsion units are available, he claimed. Combinations of today's thrust chambers with several hundreds of thousands of pounds of thrust each can be accomplished effectively to get the large amounts of power required for space work initially, the speaker contended.

Research Effort

Space programs proposed for NASA are three-fold, according to Dr. Dryden, starting with adequate research effort on problems of space technology, development and use of unmanned vehicles capable of carrying the desired scientific data gathering apparatus, and the development and orderly use of man-carrying vehicles in the exploration of the solar system.

Press representatives were shown through the reception center area and through a sample of the engineering building, a part of the production building.

High bay section of the manufacturing facility where missile final assembly is accomplished was kept closed for security reasons.

Also viewed were the research and development engineering laboratories, plus such other facilities as the centrifuge which is capable of reproducing

U.S. ARMY'S TATSA PUTS THE IROQUOIS TO THE TEST!

During the next few months the Army's Iroquois helicopter — the Bell HU-1A — will be put through a series of stringent, exacting tests. A 6 to 8-place, turbine-powered utility helicopter, the Iroquois was built expressly for front line duty with the Army.

One of the obstacle courses the Iroquois must run is the U. S. Army Transportation Aircraft Test and Support Activity 1000 hour logistical evaluation test. TATSA has developed an accelerated 1000 hour test program that must be completed in no longer than six months. The Iroquois will be flown a minimum of 10 hours each day — maintenance and upkeep must be done at night. Simultaneously other testing agencies will expose the Iroquois to every possible operating condition that may be encountered later by using units in the field.

One of the chief benefits from this testing is the tremendous savings to the government in providing the services with a tried and tested aircraft, fully capable of meeting all requirements for which it was procured. The Iroquois has already passed Bell's own exacting tests — proved its worth as a warrior. Completion of Army testing will insure that the U. S. Army has in the Iroquois today's *best* and *most advanced* helicopter.

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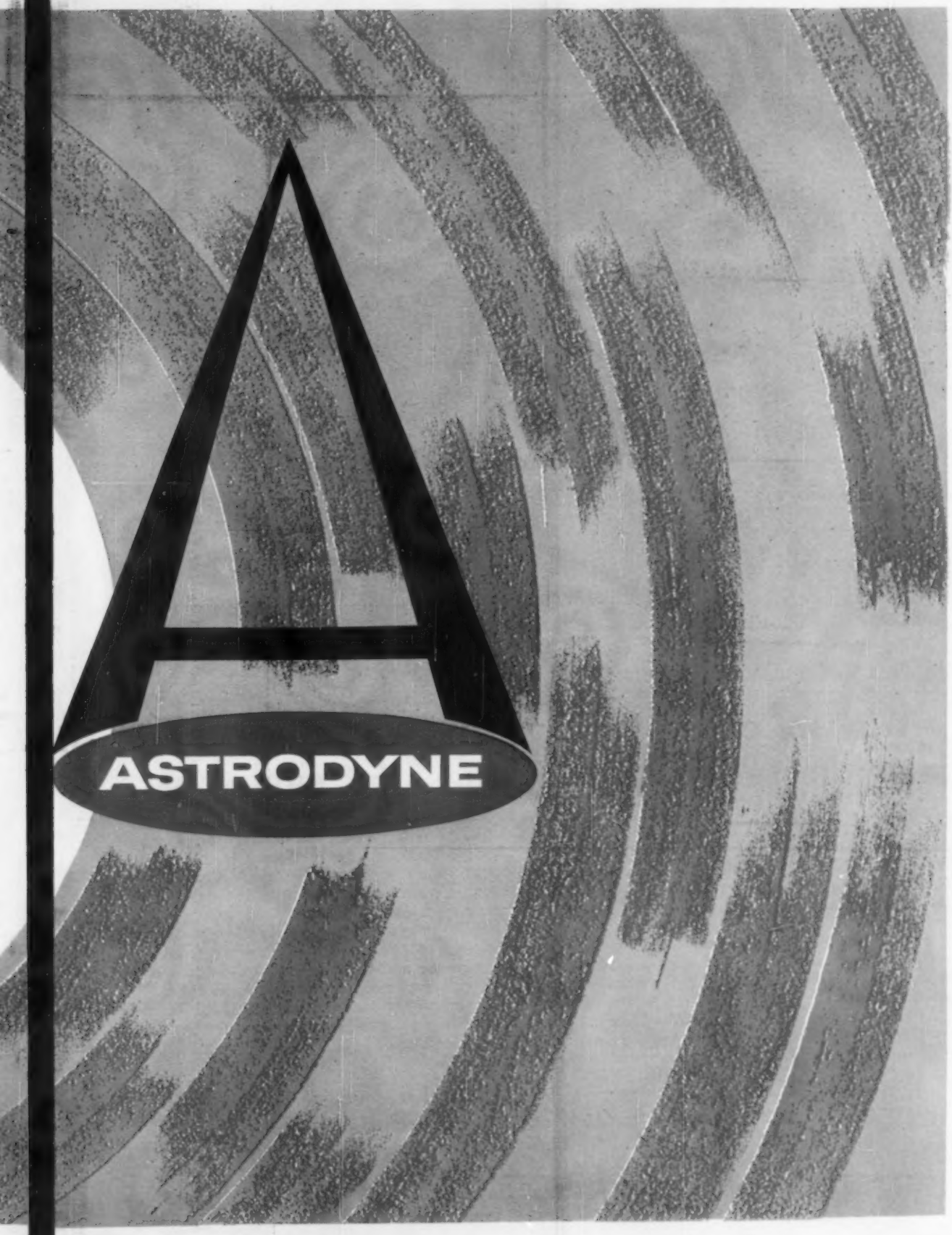
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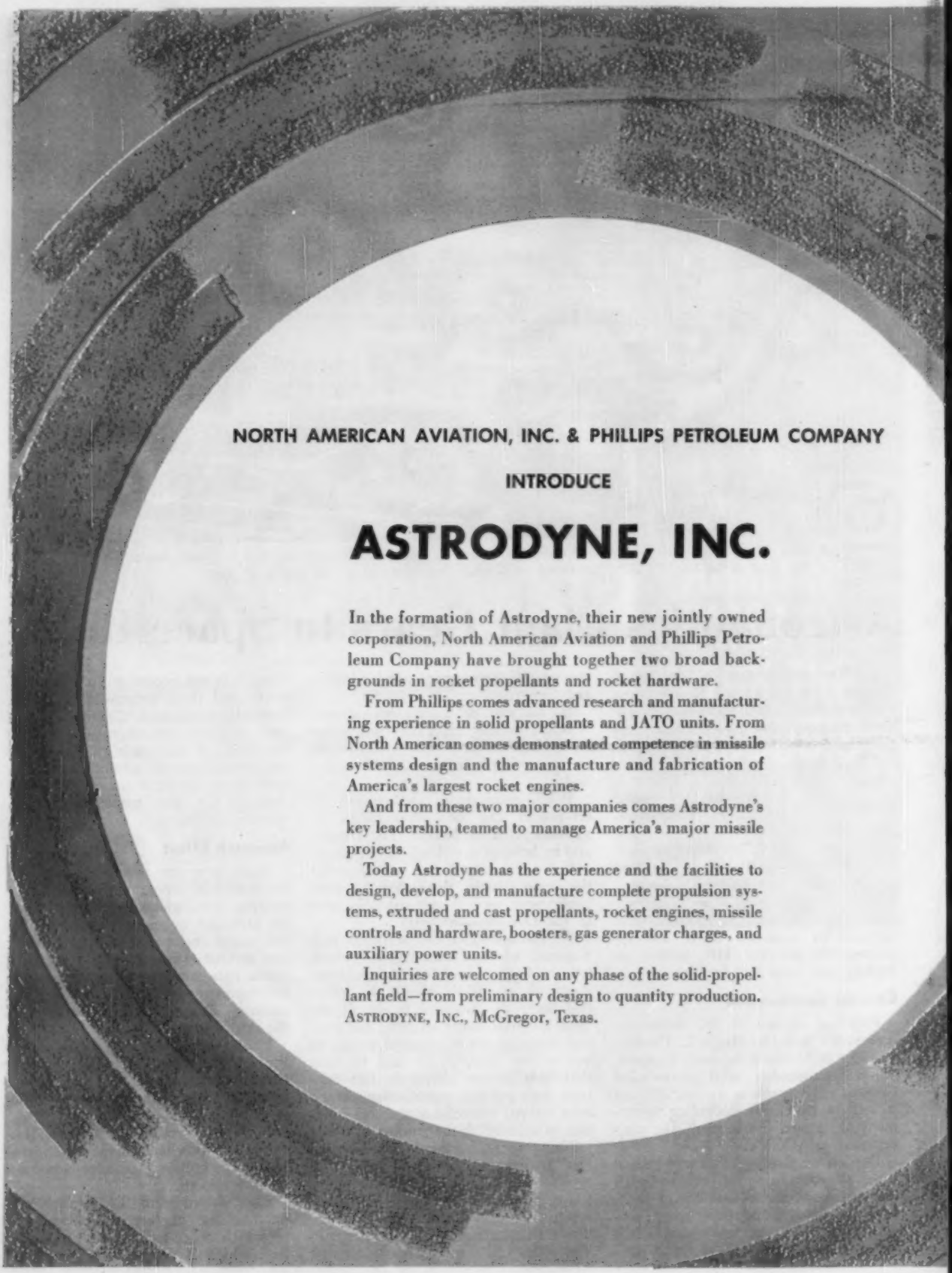

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INTRODUCE

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In the formation of Astrodyne, their new jointly owned corporation, North American Aviation and Phillips Petroleum Company have brought together two broad backgrounds in rocket propellants and rocket hardware.

From Phillips comes advanced research and manufacturing experience in solid propellants and JATO units. From North American comes demonstrated competence in missile systems design and the manufacture and fabrication of America's largest rocket engines.

And from these two major companies comes Astrodyne's key leadership, teamed to manage America's major missile projects.

Today Astrodyne has the experience and the facilities to design, develop, and manufacture complete propulsion systems, extruded and cast propellants, rocket engines, missile controls and hardware, boosters, gas generator charges, and auxiliary power units.

Inquiries are welcomed on any phase of the solid-propellant field—from preliminary design to quantity production. ASTRODYNE, INC., McGregor, Texas.

John E. Gibbons, Vice President, King Fifth Wheel Co., tells . . .

Why we chose General Electric to vacuum-melt the super alloy for these jet engine parts

"King Fifth Wheel cold-forms rectangular bar stock into rings for after-burner sections, rear frames, and other jet engine parts. We were using René 41,* the strongest vacuum-melted high-temperature alloy that can be formed, forged, and welded.

"But, we were running into trouble in the rolling operation. And rejects were raising cain with our delivery schedule. So we called in another supplier, General Electric – the original developer of René 41 vacuum-melted alloy.

"G.E. supplied us with material of consistently high quality. And, their engineers worked closely with us to help iron out fabrication problems. Today, thanks to the General Electric vacuum-melting service, we've cut rejects to a minimum . . . and we're making on-time deliveries of a top quality product."

Whatever vacuum-melted alloy your specifications call for, you too can profit from G.E.'s experience and technical know-how in the field of high-temperature alloys. For facts about G.E.'s vacuum-melting and engineering services, write: *Metallurgical Products Department of General Electric Company, 11107 E. 8 Mile Road, Detroit 32, Michigan.*

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Astronautics 20-building complex is located on 252 acres on Kearny Mesa, near Montgomery Field, 10 mi. northeast of San Diego. Floor area totals more than 1,220,000 sq. ft., which factory accounting for 579,000, engineering laboratories, 292,000, engineering and administration buildings 117,500 each, plus other structures. Plant has more than 85,000 sq. ft. of window area.

Employment at Astronautics will be increased from present 8,200 to about 9,000 by year's end. Of the Astronautics personnel, a large proportion are offsite, that is away from either the main San Diego plant, the Astronautics plant itself or the San Diego area.

J. R. Dempsey, recently elected a vice president of Convair Division of General Dynamics, is manager of Astronautics Division.

Space Man Evaluation Begun in Mountains

San Antonio—Experimental group from the Air Force School of Aviation Medicine here is living and working at high altitudes in the Rocky Mountains, collecting data which will help select the first man to go into space.

Living at the 11,000 ft. level on Mt. Evans in Colorado, the group will climb to 14,200 ft. to set up a mobile laboratory and pressure chamber. In a 42-day program, the USAF scientists and technicians will perform daily physical exercises, such as running and climbing, and record their physical reactions to such exercise at high altitude.

Data from the mountain expedition will be added to information collected during three months of physical conditioning and testing here at the School of Aviation Medicine. After they return to the school, members of the group will go through tests in the space cabin simulator.

Cabin tests will be used in determining the age, physical condition and personality of the type of man best suited to travel in space.

Mountain trip has several goals. The information gathered will contribute to the decision on the best type of man to send into space. While gathering this data, the group will also try to find ways to increase time of consciousness after loss of oxygen at extreme altitudes. Members of the group also are preparing themselves physically and mentally for later tests here in the space cabin simulator.

The group is headed by Dr. Bruno Balke and Dr. James A. Green of the Department of Physiology and Biophysics, and it includes five enlisted technicians.

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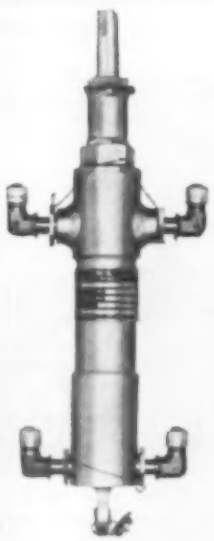
Here's a Sample of Kett Ability

The Kett hydraulic actuator controls the position of jet engine variable exhaust nozzles. The actuator develops a force of over 2,200 lbs. and has been tested for 20,000 cycles at 4,500 psi operating pressures and at temperatures up to 600° F. It is completely sealed against external leakage and it has a special locking device incorporated as a safety measure against hydraulic failure.



How Kett Can Serve You

The hydraulic actuator described here is just one example of the resourcefulness of Kett scientists, engineers and technicians. This staff has successfully completed a number of important studies and projects in the aeronautical, nuclear, electronic and mechanical fields. Complete facilities for Research and Development work as well as for the production of pilot models are available to you at Kett. You will find here the experience and trained personnel to help you develop a new product or to modify or improve your existing products. We welcome a discussion of your problem. No obligation, of course.

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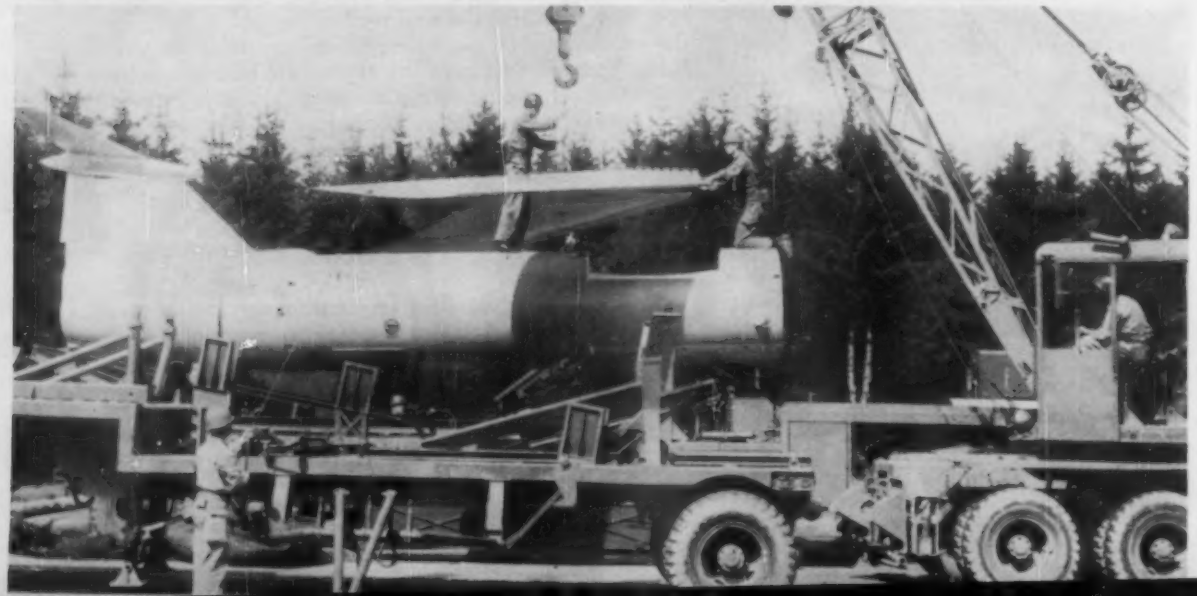
Disassembled Martin Matador missile is transferred from transport vehicle to zero length launcher at German base.

Heavy crane picks up Matador's swept wings (above). Below, missile crew installs wings on weapon. Wingspan is 28.7 ft. Crew of six men can put Matador in operational readiness in a short time. Zero launcher can also be used to transport the missile.

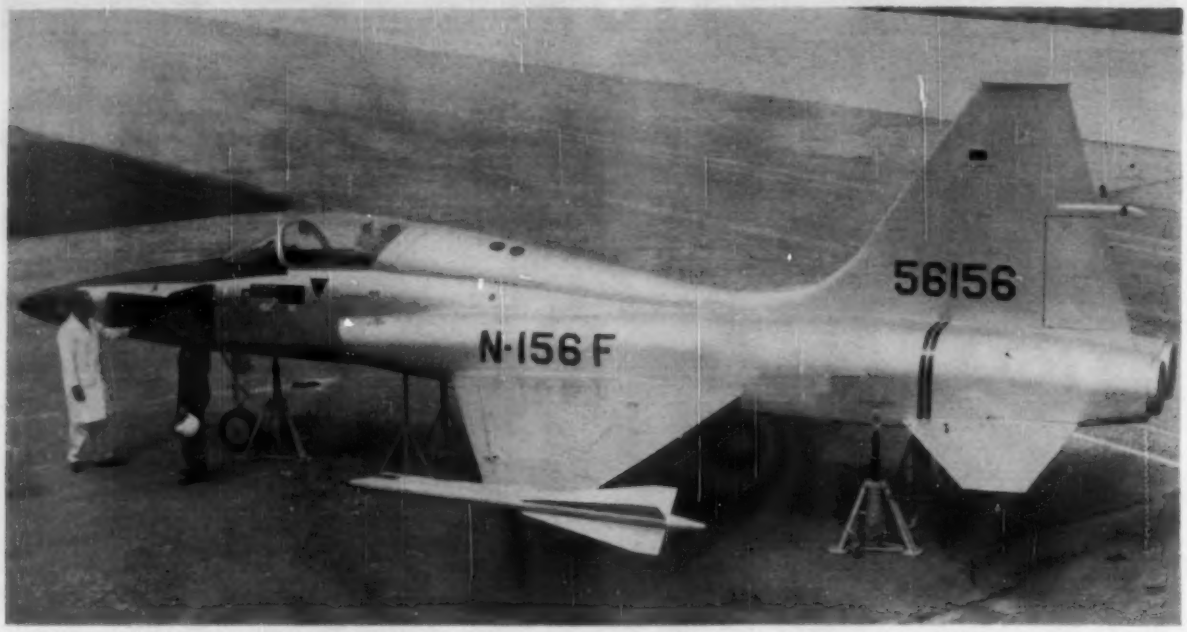


Air Force armament crew installs Matador nose cone which contains the warhead. All-weather missile has 500 mi. range.

USAF Matador Team Trains in Germany

Mid-East crisis has focused attention on the concentrated missile training program under way in West Germany where 701st Tactical Missile Wing is part of U. S. Air Force Europe's atomic striking force. Wing utilizes F-100 and T-33 jet aircraft to simulate missions of TM-61 Martin Matador guided missile. Actual firing is done periodically at Wheelus AFB, Libya, North Africa. Wing has three groups based at Bitburg, Hahn and Sembach, on western side of Rhine River. The groups will be equipped with Martin Mace missiles, using ATRAN guidance system, later this year. Current Matadors are fitted with Shanicle guidance system which requires forward target direction stations. Officers said 701st TMW is completely mobile and can operate from unprepared positions when necessary. Matador uses rocket-assisted takeoff bottle, which provides 50,000 lb. thrust for about two seconds. This accelerates the missile from 0 to 180 kt.; as rocket propellant burns out, Matador's Allison J33-A-37 turbojet engine continues missile in flight. Rocket bottle is disengaged by compressed air and drops about 600-800 yd. in front of launcher. Matador is 39.6 ft. long and has wingspan of 28.7 ft. Zero-launch pad supplies missile with electric power, cooling air and starting fuel. Launcher also elevates missile into firing position; can be used to transport fully-loaded Matador. Missile can reach altitudes over 35,000 ft. at speeds up to 650 mph. Weapon is shipped to 701st TMW in four steel containers and one wood crate.

North American F-100 Super Sabre fighter flies over Matador missile launch pad at West German site. Jet fighters and trainers are used to simulate missile's flight.



NORTHROP N-156F mock-up is shown with avionics compartment access hatch open. Equipment is installed one layer deep for ease of maintenance. Wing tip missile launchers would probably carry Sidewinder, Sparrow or Falcon missiles. Note unusual antenna that resembles an end plate on tip of the vertical stabilizer.

NATO Studies Northrop N-156F Design

By Russell Hawkes

Los Angeles—That the highest possible fighter performance does not yield the best air defense force is the underlying design philosophy of Northrop's N-156F, Mach 1.5 counter-air fighter designed for front-line NATO and SEATO air forces (AW April 21, p. 119). It is the basis of the "slow fighter" concept now being seriously studied by many U.S. fighter tacticians.

Northrop engineers say they could have obtained another .3 Mach number out of the airplane's two General Electric J85 or Fairchild J83 engines but sacrificed this to get better reliability and low speed performance and lower costs. Normal growth of engine performance with experience is expected to put N-156F in the Mach 2 class. It will fly for the first time in July, 1959. The trainer version T-38 will fly in December, 1958.

Engines around which the airplane was designed have sometimes been reported to have thrust-to-weight ratios of 8 and exceptionally low specific fuel consumption. Because of the weight saving implicit in these figures and the application of a growth factor of about 5 in fighters, Northrop is able to claim performance for a 12,000 lb. gross weight ratio fighter which is ordinarily found only in much heavier airplanes.

Air frame and engines are designed to be produced with a minimum of heavy, specialized tooling. Northrop foresees the N-156F built under license in foreign countries without advantage of heavy industry found in U.S.

Design Philosophy

Northrop philosophy of maximum performance in fighters rests on these premises:

- **Fighter performance** has become a less important factor in the shooting phase of combat tactics than air-to-air missile performance.
- **As performance is pushed** up near the limits of the state-of-the-art, cost figures rise faster than performance figures.
- **Fighter force a nation can support** in combat or in peacetime is limited by its capital resources and skilled manpower supply.

Northrop engineers argue that if the last increment of performance is becoming less important and more costly, there is some performance level in each new generation of fighters beyond which development funds are better spent on cutting the total lifetime cost of the weapon system to save money for the purchase of a larger number of airplanes and support units.

Increasing range and accuracy of air-to-air missiles and better early warning systems are making strength of numbers more important than maximum fighter performance. Number of fighters which can actually be put in the air against incoming raids is controlled by total airplane cost, ratio of the airplane's logistic requirements to logistic capacity, availability rate (percentage of total force which can be put in the air at a given time) and degree of vulnerability on the ground to enemy action. Vulnerability between missions is an especially important factor because of its effect upon attrition rate.

Operating Costs

Operating and maintenance costs are 60% to 80% of total cost over the four-year competitive lifetime of the airplane and are closely related to logistic requirements, availability and vulnerability. Complex, delicate systems of present maximum performance fighters are unreliable and difficult to maintain. This hurts availability and demands many man-hours of skilled maintenance; heavy, specialized checkout and repair equipment and large stocks of spare parts. These along with heavy fuel requirement strain logistic capacity and restrict the number of airplanes which can be supported in combat.

Maximum performance fighter is deprived of strategic mobility and made

very vulnerable to enemy action by:

• **Dependence on heavy logistic support** which ties it to the end of well-defined, easily interdicted supply lines.

• **Need for heavy, costly ground support** equipment and rare maintenance skills which pins the fighter to well equipped and staffed permanent bases.

• **Need for long runways created** by sacrifice of low speed, low altitude performance which limits the number of acceptable sites for bases.

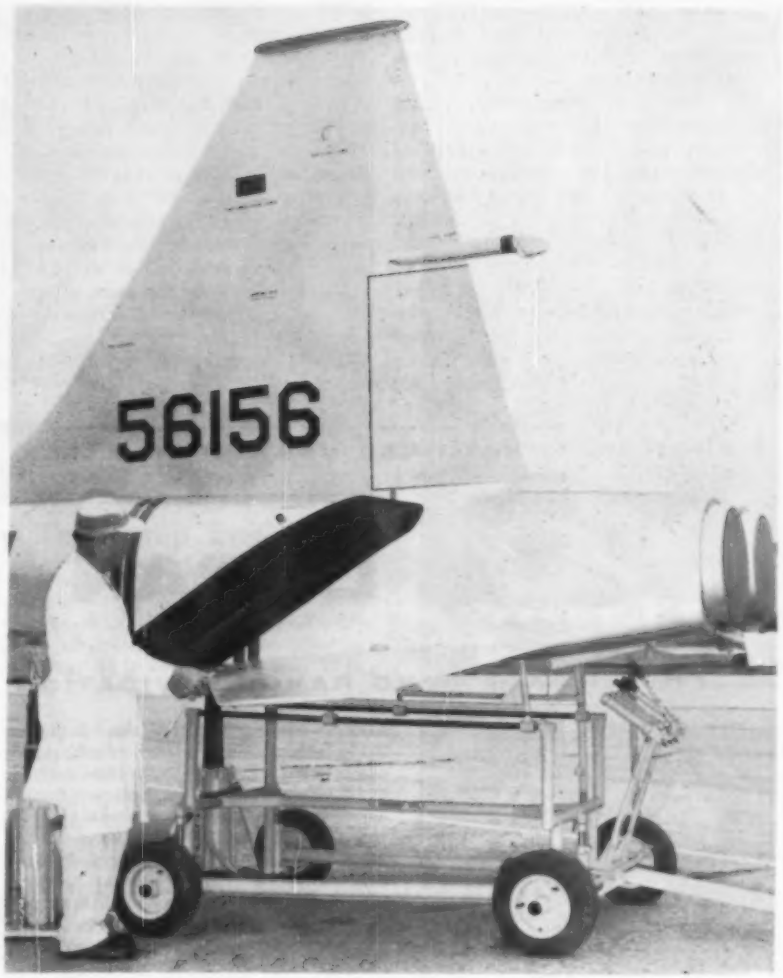
Northrop studied the circumstances of Mutual Defense Assistance Pact countries in light of these strategic relationships and concluded that there was a need for aircraft quite different from those being designed for USAF. For several years, Allied air forces could not be equipped except by giving them second-hand USAF aircraft and writing off the cost as mutual assistance money. The economies of Europe and Asia were unable to finance or build airplanes of equal merit and it would have been politically and economically difficult for U. S. to offer them brand new, first-line USAF airplanes. A secondary aspect of the giving of used airplanes was partial reimbursement of USAF out of mutual assistance money which helped finance new equipment for U. S.

Northrop feels three factors have destroyed the usefulness of the used airplane arrangement in recent years.

• **Growing strength** of NATO and SEATO economies enables many of them to provide at least a large part of the cash needed to purchase aircraft designed to their own special requirements.

• **Rising cost** of U. S. armament diminishes this nation's ability to help arm its allies.

• **Increasing demand** of U. S. maximum performance aircraft for heavy



TAIL CONE separation for engine maintenance is demonstrated on N-156F mock-up. Tail cone is attached at six points. Engines are suspended on rails at top of fuselage. Northrop-designed dolly has rails at same height, making it possible to remove engines without lifting. Note fuel dump vent over rudder.

EJECTION seat planned for N-156F uses two stage propulsion—cartridge and rocket—to provide acceleration to get pilot over vertical stabilizer at high speed.

DUMMY in ejection seat shoots skyward from forward fuselage section of Northrop T-38 trainer on sled track at Edwards AFB, Calif., during tests. T-38 rear cockpit environment and ejection system are the same as those in the single-seat N-156F.

logistic support, long runways and highly skilled, well equipped maintenance teams is getting beyond the capability of smaller nations.

So advanced is the technology needed to operate and support maximum performance aircraft, that a few nations have been obliged to turn down the free gift of Century series fighters because of inability to keep them in the air. The Dutch air force reported that the transition from Republic F-84G to F-84F caused a 25% increase in skilled manpower requirement because of the more advanced technology in the later version. The step up to Century series aircraft is a longer one technologically than Allied countries have faced and with the possible exception of Germany they may not be able to make it.

A high ranking officer of the Belgian Air Staff told Northrop, "If we are forced to accept more complicated equipment, we will not have as high a degree of combat readiness. We can accept this or call on the U. S. to help us meet our NATO commitment with men and resources. Because of the higher wages paid and other cost factors, this would be far more expensive than offering us aircraft we need and can support."

Published estimates indicate NATO air forces alone will need over 4,000 fighters of all categories by 1960. With N-156F, Northrop would abolish all-weather, day and strike fighter categories—obviously with the intent of capturing the largest part of this market by offering an all-purpose fighter. Tactical flexibility offered by all-purpose approach would appeal to air force commanders unable to obtain a wide variety of special purpose airplanes in suitable numbers to cover all possible eventualities.

In trying to sell the N-156F to foreign air forces, Northrop has faced these obstacles:

- **Emotional resistance** to the idea of buying airplanes which cannot fly as high and as fast as first line USAF and Russian fighters. Defense ministries must justify the equipment of their forces in terms of national pride and high performance figures which are more impressive to the lay public than subtle tactical and strategic advantages.
- **Allied air forces** are unaccustomed to buying airplanes still in development because of their past reliance on second-hand USAF equipment.
- **European manufacturers** are selling strike fighters to the same market with the active political support of their governments. French and German governments, particularly, have been trying to build interdependence. Germany is even providing the French with free military assistance.
- **Confusion of N-156F counter-air** mission with that of NATO strike fighters is detrimental to sales prospects of both. Strike fighter is designed strictly for the support of ground troops. N-156F outperforms it but is somewhat more expensive. Speed and altitude limitations were designed into the strike fighters to ensure that they will not be drawn way from Army support on purely air force missions. Ground attack capability of N-156F is designed primarily to be used against enemy air bases and missile launching sites.

Development Program

Much of Northrop's sales pitch has been addressed to the U. S. government. Company officials feel that a development program aimed at turning out a low lifetime cost airplane and financed out of mutual assistance money would result in a weapons system that could be manufactured under license and procured without U. S. cash by Allied governments. Military stature of Allied air forces would be increased by introduction of fighters designed to their special strategic requirements and cost of U. S. foreign aid would be reduced. Endorsement by USAF would weaken adverse prestige argument based on N-156F inability to match speed and altitude of contemporary maximum performance airplanes.

Development and transition costs

MAJOR INTERNATIONAL CARRIERS SELECT

Edo LORAN

FOR JET-AGE LONG RANGE NAVIGATION

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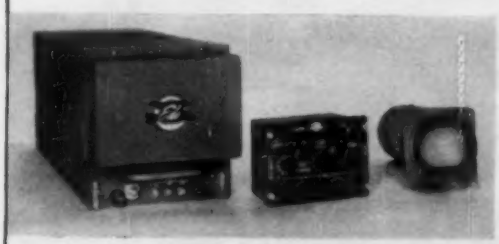
LORAN has long been recognized as the reliable, highly accurate system of long range navigation. LORAN is already implemented and in service over North Atlantic and Pacific air routes, with immediate expansion planned to cover other important areas, too.

Now, LORAN becomes an even more practical navigation system, with the development by Edo of a simplified, lightweight, *pilot-operated* unit. This compact equipment, weighing only 26 pounds installed, can be mounted in the cockpit. From it the pilot obtains directly read line-of-position information, without having to consult tables or make complicated calculations.

Thoroughly tested in trans-oceanic operation, Edo LORAN has been ordered by Pan-American, BOAC, Qantas, Cubana, Air France, KLM and Sabena for installation in their upcoming fleets of jet aircraft. Many other international carriers have also indicated their intention to use LORAN to assure precise, reliable long range navigation.



EDO AIRBORNE LORAN, Model 345

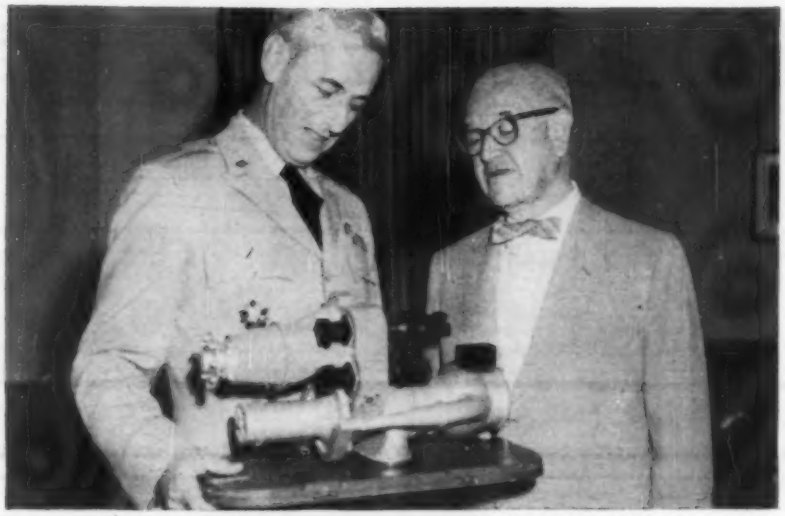
Control panel and 3-inch scope are mounted in cockpit for operation by pilot or co-pilot. Receiver (left) occupies ¾ ATR rack. Installed weight of complete system is only 26 lbs., and compact unit requires only a small fraction of space formerly required. Designed and manufactured by Edo, a major supplier of advanced electronic systems for the U.S. Navy—sonar, radar, ASW equipment.

For the complete data on Edo Model 345 Airborne Loran send for Technical Manual #501, Dept. C-7.

Edo

EDO Corporation

College Point, Long Island, New York



Allison Develops Army Turboprop Engine

Turboprop version of new 250 hp. engine being developed for U. S. Army by Allison Division of General Motors Corp. will weigh 106 lb. and will be 39 in. long. Half-scale model is examined by Brig. Gen. F. H. Britton, Army Director of Development, and Dr. William H. Martin, Army Director of Research. Turbojet engine will be used in observation and utility aircraft (AW July 21, p. 26). A turboshaft version, 35 in. long and weighing 90 lb., will be used by Army helicopters. Both versions will be manufactured by Allison.

would be minimized by close relationship of N-156F to T-38. Northrop estimates that 82% of the parts in the two airplanes will be interchangeable. Aft of the engine air inlets there is very little difference between the aircraft. The fact that they will be running along the same learning curve is considered major cost and time saving factor by Northrop. T-38 is already funded and will fly this fall. Over $1.2 million has been spent on the wind tunnel program which is now more than 60% completed. Program involves 3,400 hr. of tunnel time. N-156F will need only 1,500 hr. because of the learning transfer.

Northrop has investigated five different fire control systems for N-156F and has more or less settled on two—one simple and the other highly sophisticated. No effort will be made to firm up on one or the other because potential customers vary widely in their ability to maintain complex avionics. Also, military security rulings dictate that some countries are not eligible to receive the most advanced systems.

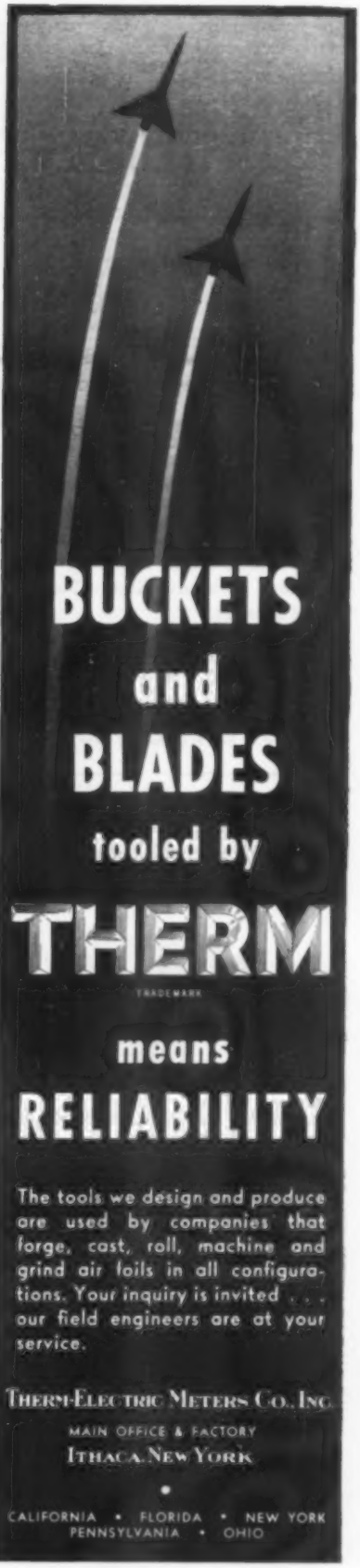
A fighter designed for service with not one but all of the NATO and SEATO countries must cope with a wide variety of special requirements. In Japan, political circumstances favor the use of a twin-engine fighter such as the N-156F; public has become very sensitive to human values. A single fatality caused by the crash of a military airplane in an inhabited area precipitates a bad press and causes ugly tempered parliamentary debates. Northrop still hopes to sell N-156F in Japan despite tentative agreement under which the Japanese would buy and build Grumman F11F-1F. Reliability and safety offered by twin-engine design are key talking points.

German Market

Northrop officials think it likely that Germany will buy N-156F and an airplane in the Lockheed F-104 class as well as the Fiat G.91 strike fighter which is already ordered. They consider Germany to be one of the few Allied countries with the economic strength and technology necessary to operate a maximum performance fighter like F-104 and also able to afford the specialization inherent in the strike fighter concept.

They believe Germany's strategic and political circumstances ensure a place for the N-156F in the air defense structure. Number of runways which can be stretched to accommodate maximum performance fighters is limited because West German government lacks right of eminent domain. This means German air force would be compelled to buy land at the seller's price, regardless of how high, to provide a large number of bases. Few existing adequate bases would call for relatively small enemy effort to be neutralized. Northrop believes N-156F operating from small advanced fields could take some of the heat off the big bases by offering a comparatively hard-to-destroy defense.

The Luftwaffe used a similar system during the later phases of World War II when USAF and RAF could destroy German bases almost at will. Luft-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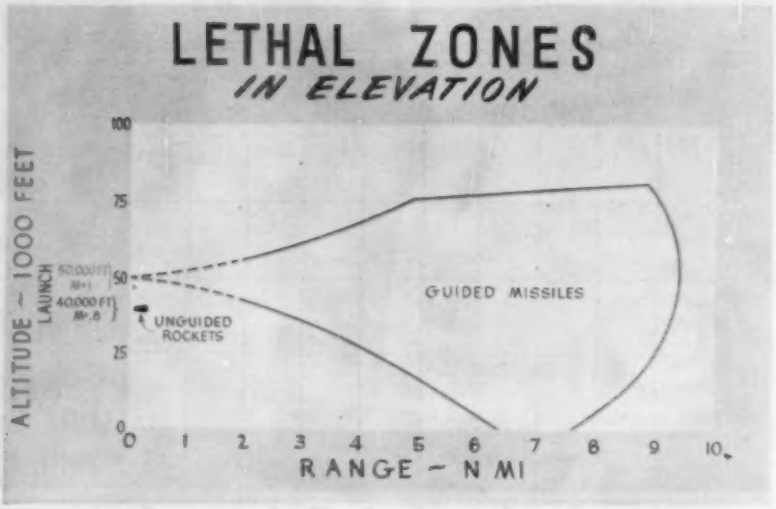

DIFFERENCE between kill areas of guided and unguided armament demonstrates greater freedom of selection of firing point by N-156F equipped with guided missiles.

waffe squadrons and mobile support units rotated continuously among a large number of small temporary bases called "Einsatze," some of which were located on straight segments of the Autobahn system. The Luftwaffe continued to put up a dangerous air defense long after it should have been ruined because when Allied reconnaissance discovered German planes at an Einsatz, a raid could seldom be organized before the fighters would move on to another. Wherever the fighter squadrons went, they were preceded by night-driving anti-aircraft units and maintenance echelons.

Northrop foresees the Einsatz used in N-156F squadrons. Its value could be augmented by use of zero length launch. Booster and ground support equipment of Martin Matador surface-to-surface missile could be converted to this purpose.

Combat Mission

N-156F is intended for air-to-ground as well as air-to-air armament and has 750 mi. combat radius. Most efficient way to eliminate enemy air and missile power is to attack it on the ground or cripple its logistic support. Ability to hit targets on the ground enables N-156F to provide close support of ground troops but speed, range, rate of climb, service ceiling and special fire control equipment needed for air intercept mission makes it a more expensive airplane than the true strike fighter.

Counter-air fighter designed under the philosophy of the N-156F is still much less expensive and much more easily maintained in combat than one designed for the very ultimate speed and altitude figures attainable in its generation. Northrop studies indicate that the last 5% increment of performance accounts for 50% of development costs and is usually obtained by compromising production costs, operation and maintenance costs, strategic mobility, logistic requirements and squadron availability rates.

At the beginning of the N-156F project, it was apparent that the new design would be competing against Mach 2 airplanes, yet Northrop chose to

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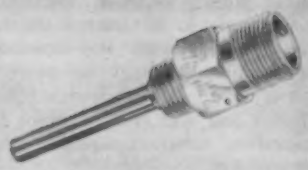
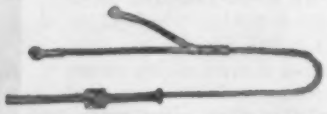
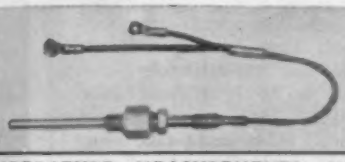


THREADED, PROBE TYPE MS28034-1 and MS28034-2 to MIL-B-7990

CYLINDER HEAD, BAYONET TYPE AN5546-1 to MIL-B-5491



PROBE TYPE, WITH ADJUSTABLE STAINLESS STEEL STUFFING-GLAND



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IX

This is the ninth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

The Effect of Nickel in Alloy Steels

Each element in an alloy steel has its own particular job to do, and each is included with a special purpose in mind. What are some of the reasons, say, for using nickel, chromium, molybdenum, vanadium, and other components that appear in the various analyses? The elements in any alloy steel work both individually and as a team. What does each one do? In this and subsequent discussions we shall try to answer these questions, beginning with nickel, one of the fundamental alloying elements.

Nickel increases toughness and resistance to impact, particularly at low temperatures; lessens distortion in quenching; improves corrosion-resistance. It lowers the critical temperatures of steel and widens the temperature range for successful heat-treatment.

Nickel steels are particularly suitable for case-hardened parts, such as aircraft-engine gears and roller bearings. Such steels provide strong, tough, wear-resistant cases and also ductile core properties.

Advantages imparted by nickel are not restricted to quenched-and-tempered steels. Nickel often permits given strength levels to be obtained at considerably lower carbon contents, thereby markedly increasing toughness, plasticity, and fatigue-resistance. Nickel steels are therefore highly suitable for applications where liquid quenching is not employed, such as high-strength structural steels used in the as-rolled condition or heavy forgings not adapted to quenching. Products of this nature must develop superior properties after nothing more severe than air-quenching treatments.

If you would like to know more about nickel steels, or need information about other types of alloy steels, please feel free to consult with Bethlehem's metallurgists. These technicians will gladly advise you regarding analyses, heat-treating, machinability, etc. You are invited to make use of their services whenever you need assistance.

And may we remind you, too, that Bethlehem makes all AISI standard alloy steels, as well as special-analysis steels and the full range of carbon grades. We are always in a position to meet your needs promptly and fully.

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BRIDGEPORT PRESSURE SWITCHES

New bulkhead-mounting Bridgeport Pressure Switches represent true miniaturization for your rocket, missile and aircraft applications. Ruggedly built to withstand vibration up to 2000 cps ±10 g's in any direction. Piston actuator is insensitive to vibration fatigue and rapid temperature cycling. These compact Pressure Switches can be grouped on 1.09" centers . . . and even the heaviest one weighs less than 4 oz. Actual sizes are shown above.

• 20 to 500 psi pressure settings • 2300 psi proof pressure (piston bottomed against mechanical stop) • —65° to +250°F ambient temperature range • Vibration: 0-2000 cps ±10 g's in any direction • Handles combustion gases, fuel, oil, H_2O_2, helium, etc. • Switch heads encapsulated in epoxy resin • 20,000 cycles minimum life • Weight: .240 lbs., .170 lbs., .150 lbs., (top to bottom above)

Other Bridgeport Pressure Switches are available to meet your specific requirements on mounting, electrical connections and for pressure ranges from 2 psi to 3,000 psi. Write for Data Sheet J-207.

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accept a Mach 1.5 speed limitation and turn more of its development effort to the problem of maximizing the number of airplanes which could be brought into action. Logically, this should yield a tighter air defense. A fast airplane can defend a wider sector than a slow one, but it must be more than twice as fast to cover the same sector as two slower airplanes.

Custom of designing fighters to outperform bombers grew out of the pursuit curve and tail chase tactics needed to cut relative speed and improve hit probability of gun and unguided rocket armament.

Obsolete Tactics

Most fighter tacticians are convinced that supersonic bombers and guided air-to-air missiles have made these tactics obsolete. Longer range and self-contained guidance of modern air-to-air missiles have radically improved hit probability in forward hemisphere attacks (see graph, p. 58). A supersonic fighter sucked into the aft hemisphere of a supersonic bomber may not close to within shoot range before the bomb release line is reached because:

• **Flight time to the release line** is reduced by the high speed of the bomber and the use of air-to-ground missiles.

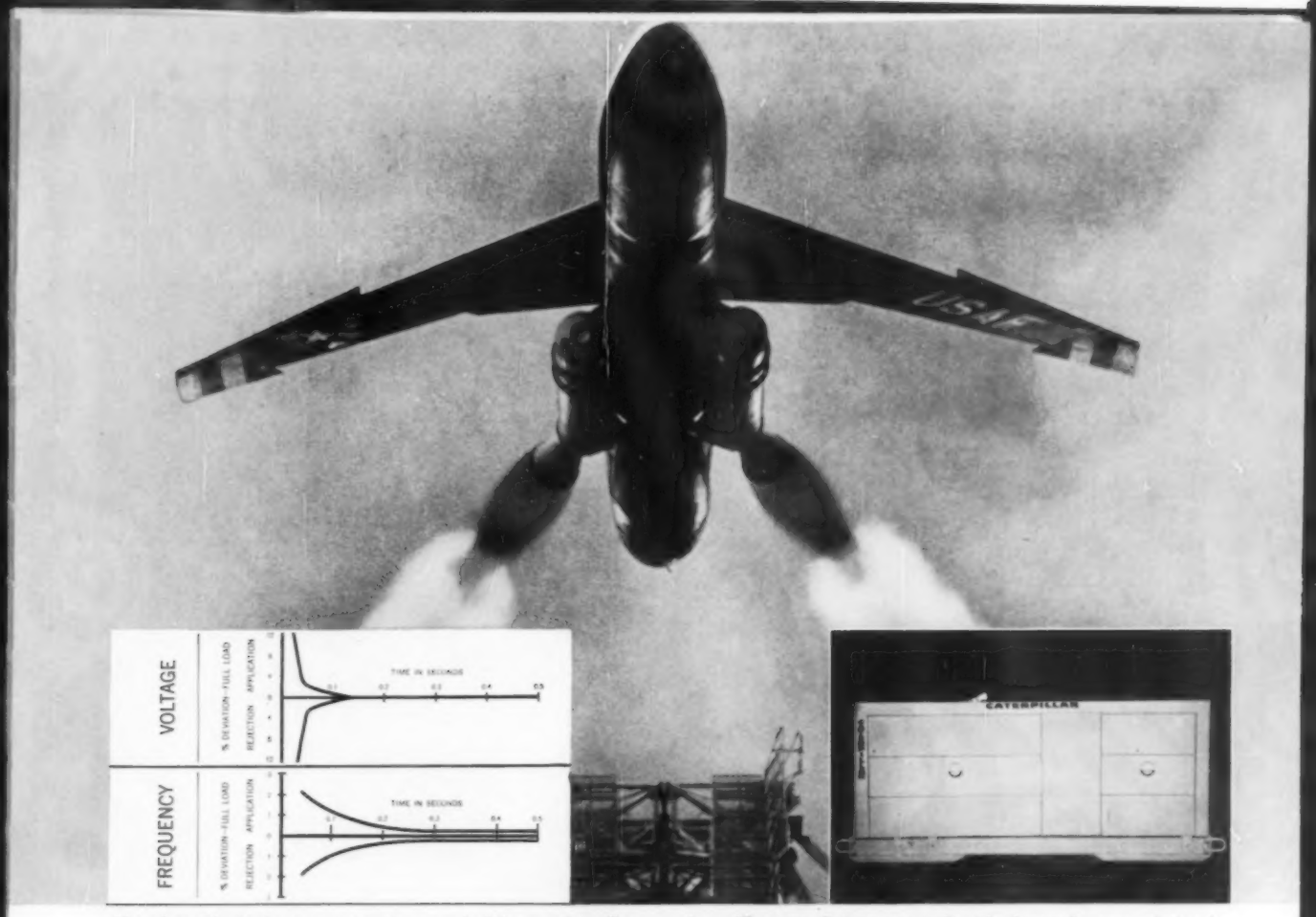
• **Fighter must close** to shorter range in a tail-chase approach because speed of missile relative to its target is less on an overtaking course than it is on a crossing or head-on course.

• **Vital time-distance is lost** in turning onto the bomber's heading to line up the speed vectors of the two airplanes and overtake as quickly as possible. Fuel, as well as time, is rapidly consumed during this process.

• **Wide turning radius** of high speed fighters means pursuit curve firing approach may be started with the target beyond the range of airborne detection. This would call for an excellent Ground Controlled Intercept (GCI) system which might not be available after the first few days of attrition in combat.

Unguided armament must be fired within narrow envelopes of range and relative altitude. Rapid closure means fighter is difficult to place within these envelopes and is there for such a brief period that the human pilot is incapable of maneuvering and aiming in the short time available to him. During the firing run, he must be removed from control of the airplane and replaced by heavy, unreliable fire control equipment. Guided air-to-air missiles allow the firing point to be positioned much more loosely in time and space. Pilot can be put back in the system with a large weight saving in the fire control system and an improvement in reliability and cost.

Greater freedom in selecting firing



The almost instantaneous return to normal of the new low-silhouette Cat power unit under conditions of full-load application, and load rejection (117.4 volts), is shown in the above graph.

Low-silhouette Cat power unit with close voltage regulation is now being used in connection with ground support for jet starting and firing. The 400-cycle phase is specifically adapted to missilry.

Caterpillar power fires SNARK...first U. S. intercontinental missile

The U. S. Air Force SNARK SM-62, the first U. S. intercontinental guided missile, is fired with power from an electric set, developed by Caterpillar and now being supplied to the military.

The full designation of this specialized power unit is Caterpillar 60 KW 400-cycle 120-208 voltage low-silhouette portable ground support unit with precision voltage regulation.

The secret of this unit is the almost instantaneous recovery to both applied and rejected loads.

Other advantages found in all Caterpillar Engines include: trouble-free operation over a wide range of loads; dependability and long life; economy of operation; maintenance and operation by unskilled personnel; world-wide parts and service, and the ability to operate on any fuel from JP-4 through No. 2 furnace oil.

Creative engineering and quality of manufacture have made Caterpillar the diesel leader for more than 25 years. For detailed information on the Cat 60 KW 400-cycle portable power unit with close voltage regulation, send in the coupon below.

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position reduces the significance of fighter performance in the firing run. Forward hemisphere attack actually makes speed a disadvantage since it increases closure rate and reduces the time available. Advantage traditionally conferred by altitude may also be disappearing with advent of guided missiles. Better infrared and radar returns can be had in attacks from below, escape may be easier and the fuel saved by not climbing to a higher altitude offers more combat radius.

The N-156F is designed around these characteristics of guided missile armament. The airplane is intended for nations with their fighter bases right on top of their early warning radar line and with GCI systems ranging from good to non-existent. Minimum bomber penetration and minimum GCI dictate use of forward hemisphere attack. Therefore, all the performance needed is high enough speed and rate of climb to get the fighter between the bomber and its target in the time allowed by existing early warning system and high enough operational ceiling so fighter's missile can reach up to bomber's operational ceiling. Northrop calculates that N-156F offers this for all its potential buyers.

Northrop tried out its concept in a series of intercept exercises on paper in which a maximum performance, Mach 2 fighter and N-156F were pitted against identical Mach 1.5 and Mach .9 bomber raids into West Germany. Each fighter force was procured, trained, operated and supported for the same amount of money and within the same logistic limitations. Each took as much advantage of West German strategic opportunities as possible given the limiting characteristics of their respective airplanes.

Armament and fire control systems were identical.

Successful Intercepts

The N-156F force made 1.7 times as many successful intercepts of Mach 1.5 raids as the maximum performance fighter force and 1.75 times as many intercepts of high subsonic raids. The bombers came in at altitudes ranging from 50,000 ft. to 60,000 ft. and N-156F fired from altitudes between 45,000 ft. and 50,000 ft. Best cruise of N-156F was only about 30 kt. below that of the maximum performance fighter at altitudes above 35,000 ft., though top speed was more than 300 kt. slower. Fuel consumption per mile was one-half that of the maximum performance airplane.

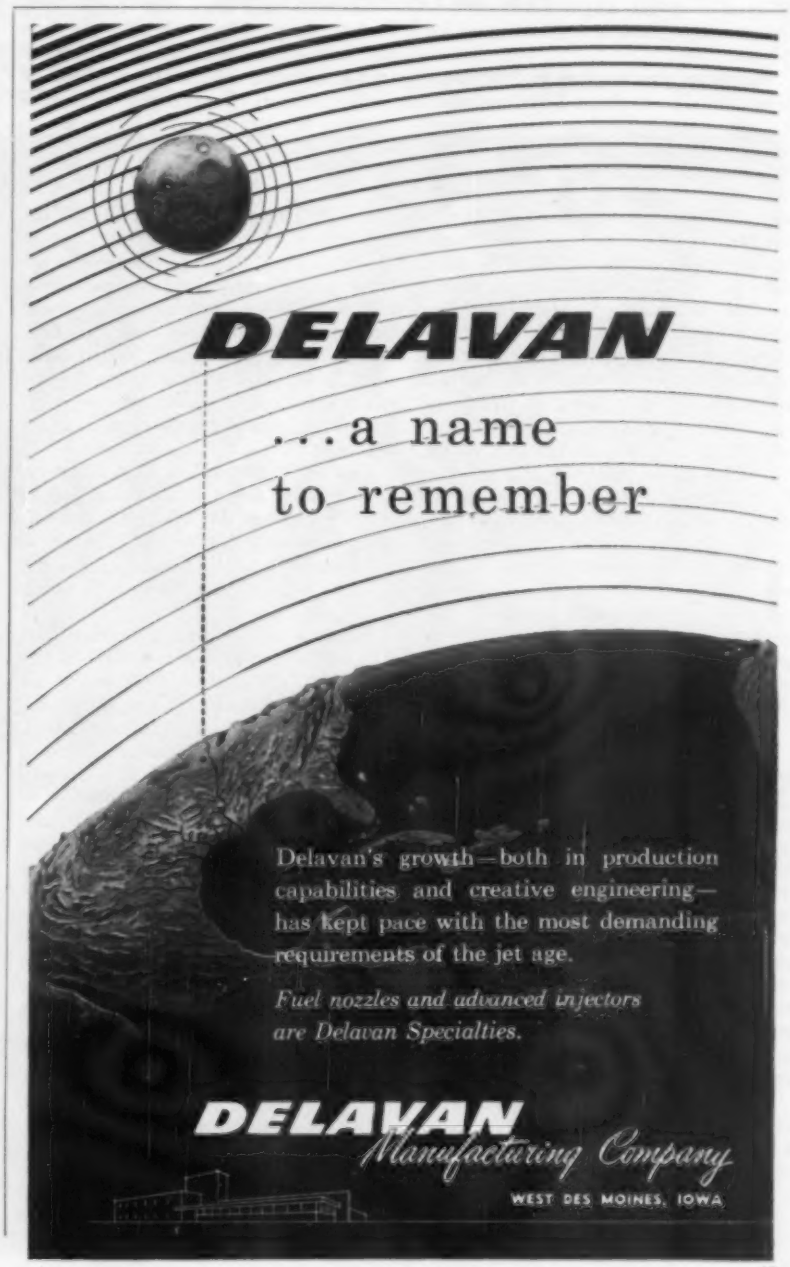
Purchase price of N-156F was a bit over half that of its competitor and maintenance man-hours per flight were also approximately half as many. These facts gave N-156F an edge despite its lack in speed and altitude capability. According to Northrop calculations N-156F should have these advantages:

• **Strategic mobility.** The N-156F force can be dispersed to many 3,000 ft. runways and highway segments not usable by other fighters and mobile support units are more difficult targets than highly developed bases. Mobile N-156F support is made possible by simple modular systems and small fuel requirement. Net effect is freedom from easily interdicted supply network and fixed bases.

• **High availability.** Twin-engine design enables N-156F to return after inflight failure of an engine. It also makes possible duplication of hydraulic pumps and electrical generators and eliminates the necessity of dead-weight back-stop systems to guarantee return of the airplane after failure of a primary system.

• **Combat radius.** Northrop says 750 mi. combat radius of N-156F enables it to protect a wider area and gives it a greater potential for offensive penetrations against enemy missile pads, airfields and supply lines than most modern fighters. This is a necessity for some of Northrop's possible buyers like Turkey which faces Russia across the Black Sea and must cross water to find targets.

The N-156F and its sister ship, the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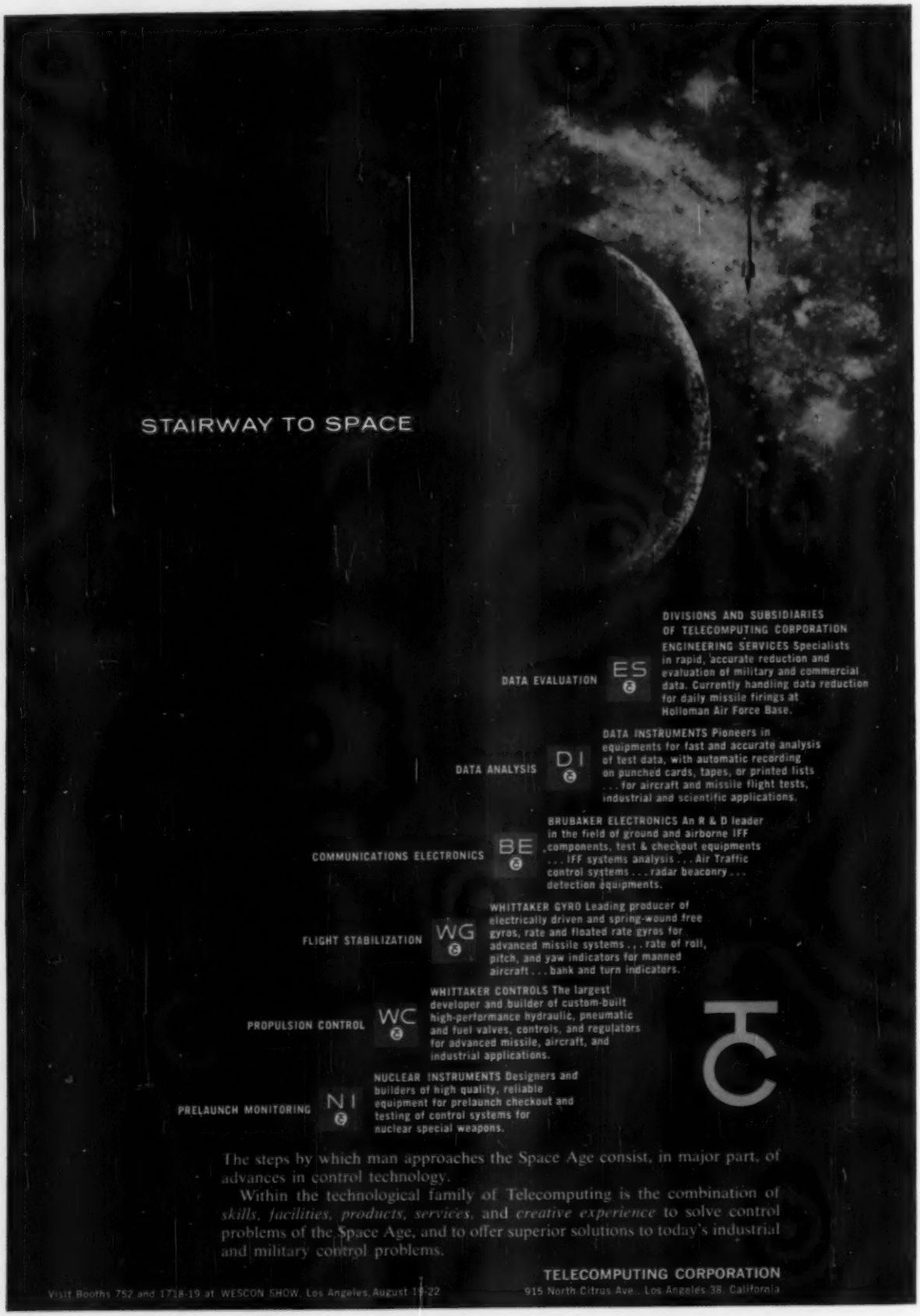
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Vought Vocabulary

dy·nam′ic: *a manned weapon for space-edge duty designed in the image of a champion*

With Chance Vought's new F8U-2 *Crusader*, America's defense strength rockets to the threshold of space. This Navy fighter has the speed, range and staying power to master the upper atmosphere. A manned aircraft, its pilot brings human intelligence to an advanced aerial weapon whose capabilities outstrip those of ordinary jet fighters. At his command, this lethal weapon can hide and seek . . . strike and strike again.

On its first flight, the F8U-2 easily beat the fastest official speed of the record-breaking F8U-1 *Crusader*. It climbed to heights reached a few years ago only by rocket-powered research craft. It carries advanced fire-control and radar systems, and awesome armament: 20 mm cannon, 2.75-inch rockets, Sidewinder missiles.

The dynamic design of this new carrier-based fighter is a *proven* one . . . incorporating the finest features of the celebrated F8U-1 *Crusader*, already giving Navy pilots unmatched air/sea strength.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. M-12.

CHANCE VOUGHT AIRCRAFT
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T-38, entered preliminary design near the end of 1955 when Northrop heard reports of the lightweight, low specific fuel consumption turbojet engine being developed by General Electric and Fairchild Engine and Airplane Corp. for missile application. Fairchild Bull Goose and McDonnell Green Quail counter-radar missiles were intended to receive the J83 and J85. Northrop engineers regard the development of the small, lightweight engines as an authentic breakthrough. No new principle is involved but engines are more thoroughly engineered from the standpoint of weight, reliability and cost. General Electric J79 was first engine to bring weight considerations in at the preliminary design stage. It is said to have achieved a thrust-weight ratio of 5:1. Thrust-weight ratio of 8:1 is claimed for J83 and J85.

Weight of two engines in N-156F is about 950 lb. or about 25% as heavy as single engines used in many current high performance fighters. The twin J85 or J83 installation produces about 50% as much thrust as the heavy single engine. Much of the advantage of the small engine installation is derived from the operation or the so-called Square-Cube or 3/2 Power Law which states that the thrust of a turbojet varies approximately with the square of a characteristic linear engine dimension while its weight varies with the cube of the dimension. Cost of the two small engines is substantially less than that of a single large engine. Airframe cost of N-156F is about half that of a current Mach 2 fighter, so flyaway cost amounts to about 60%. Maintenance, fuel, personnel, training, attrition replacement, installations and fixed costs come to approximately 65% of those costs for a maximum performance type. The total yearly cost of procurement and operation with procurement amortized over a four-year period is between 60% and 65%.

The N-156F will take-off and land in a 3,000 ft. sea level airport over a 50-ft. obstacle. It touches down at less than 120 kt. Northrop engineers say they could have attained .3 Mach number higher maximum speed for the first airplanes off the line but only by boosting field length to 8,000 ft. Normal engine performance growth is expected to push maximum Mach number up around 2 without any sacrifice on the low end of the speed scale. The engines are now just at the beginning of their growth curve. Normal growth of thrust in the competitive lifetime of an engine design is about 40%.

The airframe is area ruled and has a very extreme wasp-waist in the fuselage at the wing roots. Area rule design point is Mach 1.3. Drag rise at Mach 1 is 30% of the total.

Quarter-chord line of the wing is swept back 25 deg. Trailing edge is swept forward 10 deg. Leading edge extension at wing root has 60 deg. swept. The wing has no dihedral, an aspect ratio of 3.75 and a thickness ratio of 4.8% with maximum thickness occurring at about 45% M.A.C. A modified form of conical camber is used on the leading edges which is equivalent to about a three degree leading edge droop. If it were not cambered, sharp leading edge would cause stall to occur at an angle of attack of three or four degrees. Camber postpones stall to any angle of attack of 10 deg. N-156F will have leading edge slats which extend at eight degrees permitting angle of attack to be increased even higher before separation occurs.

Ailerons and flaps are both 30% M.A.C. deep. Flaps extend from fuselage skin (15% semispan) to 50% semispan. Ailerons extend from there to 75% semispan. Boundary layer control flaps are being investigated but there are no firm plans to install them. Stability of the N-156F has been simulated on the variable stability F-86E at NACA Ames Aeronautical Laboratory. It has proved to have good lateral stability through the stall. Pitch and yaw stability augmentors based on rate gyros will be installed to damp high natural frequencies at supersonic speeds. Loss of the augmentors would not be considered especially dangerous at any anticipated speed, Northrop engineers say, but control would be hard work for the pilot.

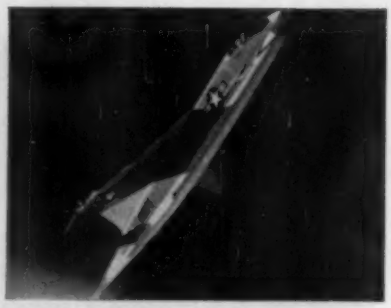
Low set slab stabilizer has a three degree negative dihedral. Its hinge line is at 38% exposed M.A.C. All tail surfaces have same leading edge sweep as wing and 4% thickness ratio. Rudder is 30% M.A.C. deep and 50% semispan long.

Subsonic wind tunnel testing was done at Northrop's own facility. Transonic testing was done at Cornell Aeronautical Laboratory and supersonic runs were made at Ames unitary tunnel. Northrop also expects to use the unitary wind tunnel at USAF's Arnold Engineering Development Center.

Fuselage is constructed of steel frames and 75ST longerons. Nose section skin is also 75ST but some magnesium is used elsewhere, notably in the engine air inlet lips and about 40 in. aft. Titanium shrouds are used in the engine area. Two extruded and two stepped extruded longerons provide a strong four-point attachment between the nose and center fuselage sections.

Wing Structure

The wing has a one-piece primary structure with six spars mounted on six trunnions. Main trunnions carry lift, drag, landing, and side-slip loads. Forward spar is at 15% M. A. C. Aft continuous spar is at 44% M. A. C. There



KEY ENGINEERING OPENINGS AT VOUGHT

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The technical areas include the fluid mechanics and heat transfer aspects of supersonic and hypersonic flow, propulsive systems (air breathing, rockets, nuclear, ionic), high temperature and cryogenic equipment. Following are 3 key openings:

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Analytical Design and Development Engineer. M. E., or A. E., advanced degree, for work on environmental conditioning or auxiliary power sources and equipment.

Staff Engineer. Advanced degree (Ph.D. preferred) specialized in aerothermo engineering or physics, plus 5 years applicable to aircraft nuclear propulsion or other advanced propulsive concept. Must be capable of handling the technical phases of the design work on these systems.

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complex that only by a combined effort of military and civilian research and development groups can the U. S. reach its national defense goals.

Space flight has complicated aeronautical research and development problems since the first ARDC materials symposium was held in 1956, Gen. Demler said. "Regardless of the medium in which the Air Force must operate, our objective remains clear—to provide airpower inferior to none," he said.

ARDC symposium was held to promote an exchange of information among military and civilian specialists in the field. ARDC discussed its future objectives and the materials bottlenecks that stand in the way. This was an effort to inform scientific groups in industry and the universities of ARDC needs so they can aim toward specific goals.

Sikorsky Predicts Helicopter Load Gain

Bonn—Within the next 10 years, Igor Sikorsky predicts, helicopters will be capable of handling up to at least 100 tons in weight. Within five years, he feels sure that flying cranes would be lifting loads from 20 to 25 tons.

Speaking at a German Helicopter Society meeting attended by top-ranking Army officials, engineers, scientists and industrialists, Sikorsky said that the main thing would be to modify or dispense with the conventional heavy cabin and provide a lightweight rig allowing the load to be slung under the helicopter belly at the true center of gravity. One of the two pilot seats would have to be designed to turn through 180 deg. and controls provided so that the machine could be flown backward with ease. Larger machines would also carry a third man to look after and operate the lifting gear.

In the future, Sikorsky said, he foresees helicopters being used to tow ships or vehicles, and added that very soon helicopter companies would be running "house-to-house" services using containers fitted to carry passengers.

Although he foresaw no technical obstacles to building 300-passenger helicopters, Sikorsky thought the idea would not catch on because the effective range of the machine would be limited to about 175 mi. nonstop. He said five 60-seat helicopters would probably pay off better than a single 300-passenger machine, for even under the most favorable circumstances it would be next to impossible commercially to fill all the seats of a plane making such short hops.

Future long-range helicopters will probably be amphibious, concluded Sikorsky, so they can be re-fueled from tankers at sea.

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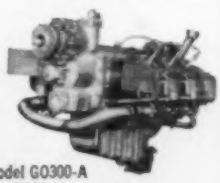
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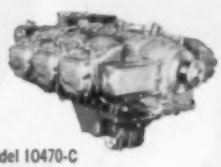
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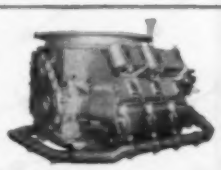
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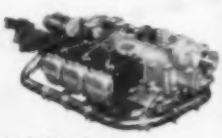
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O470-M	240	2600	6	409	91/96
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is a discontinuous spar at 66% m.a.c. which carries only vertical loads and has a fore and aft slip joint at the root to allow fuselage bending. There is a single tapered skin on the upper wing surface and another on the lower surface composing a single, complete structural box. Wing skins extend all the way to the tips.

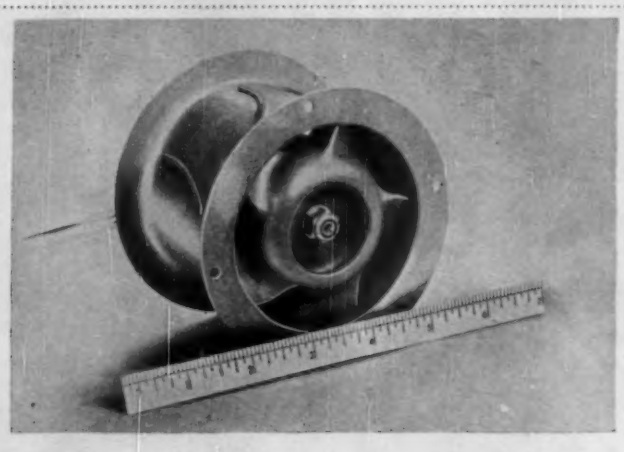
Stabilizer is a honeycomb structure. Fin consists of a single structural box with one spar at the center, to which the rudder torque tube is attached, and two false spars, one forward and one aft. Stabilizer torque tube is continuous through the fuselage with an assembly joint in the middle. Removable tail cone has six attachment points. All internally stored fuel is kept in fuselage bladder cells. About 50% of the fasteners in the fuselage center section are blind bolts. Huck fasteners are used throughout the airplane. A double keel in the nose takes nosewheel landing loads.

A hydraulic pump and an electrical system alternator are driven by each engine from its accessory pad through an extension shaft and a two-speed, airframe mounted gear box. Automatic governors controlling the gear box speed selection narrow the range of frequencies in the alternators while avoiding the weight, expense and unreliability of constant speed drives and provide high volume flow in the hydraulic system at traffic pattern speeds without causing unnaturally high flow rates at maximum power settings.

About 95% of a.c. electrical equipment has been chosen because it is relatively insensitive to frequency variations. Two-speed drive allows frequency to range from 320 cps. to 480 cps. The remaining 5% of the a.c. loads have an additional regulator to hold frequency within tighter limits. There are two separate a.c. load busses which operate unparalleled unless one system fails, in which case, the other takes over the entire load. All essential loads are maintained with one system out including the flaps which are electrically driven. Rectifiers provide the small amount of d.c. needed for such things as instruments. Battery is used strictly for preflight checkout.

All controls are hydraulic powered and without manual backup systems. Each control surface has dual actuators. One set is driven by right engine and the other set by the left engine. Loss of one engine or one system allows full control deflection but reduces hinge moment capacity by half. Both hydraulic systems operate at 3,000 psi. Landing gears are retracted and extended by the left hand system. Gravity and aerodynamic drag upon the forward retracting nosewheel provide the power for emergency extension. Multiple disk wheel brakes are operated by a separate open center system powered only by the pilot's leg force. This is considered adequate because of the light weight of the airplane. A drogue chute will be installed in a pressure packed, insertable cylinder and will be manually released.

Avionics will be offered a la carte because of the wide variety of possible requirements to be met for the many potential customers. Electronic countermeasures would be podded.



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ARDC Encourages Materials Research

Dallas—Improved materials are the common denominator in the effort to reduce weight and improve efficiency, reliability and life expectancy of new weapons, Maj. Gen. Marvin C. Demler told a symposium on materials sponsored by Air Research and Development Command.

Development of new and vastly improved materials will lead to subsequent improvement in the performance of aeronautical and astronautical weapons, according to Gen. Demler, ARDC's deputy commander for R&D.

Calling for the cooperation of the civilian scientific and industry community, Demler said the scope of the materials problem has become so broad and

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USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices:

HEADQUARTERS, AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, Air Research and Development Command, Washington 25, D. C.

California Institute of Technology, Pasadena, Calif., continuation of research on "Properties of Air and Propellant Reactions at High Temperatures and Pressures," (AF 18(603)-2), $52,480.

Johns Hopkins University, Baltimore, Md., research in "Boron Hydride Chemistry," (AF 18(600)-1526), $40,897.

California Institute of Technology, Pasadena, Calif., research on "Panel Flutter," (AF 49(638)-220), $131,575.

Board of Trustees of the Leland Stanford, Jr., University, Stanford, Calif., research and reports concerning "Chemical Applications of Nuclear Magnetic Resonance," (AF 49(638)-286), $35,960.

Trustees of the University of Pennsylvania, Philadelphia, Pa., research on the "Origin of Deformation Bands," (AF 49(638)-435), $41,590.

Duke University, Durham, N. C., continuation of research on "Microwave and Radio Frequency Spectroscopy," (AF 18(600)-497), $245,872.

Regents of the University of California, Berkeley, Calif., research on "Infrared Spectra of Free Radicals and Unstable Intermediates," (AF 49(638)-1), $34,380.

Regents of the University of Minnesota, Minneapolis, Minn., research on "Aerodynamic Heat Transfer Studies with Evaporative Cooling," (AF 49(638)-190), $74,807.

New York University, New York, N. Y., research on "The Variables and Conditions of Small Group Interaction," (AF 49(638)-195), $51,850.

State Board of Control, acting for and on behalf of Florida State University, Tallahassee, Fla., research and reports concerning "NMR Study of the Structure and Reactivity of Molecules," (AF 49(638)-278), $28,552.

University of Pittsburgh, Pittsburgh, Pa., research on "Antiferromagnetic Resonance, Para-Magnetic Resonance in Phosphors, Foreign Atoms in Silver Halides and Nuclear Resonance," (AF 49(638)-323), $42,455.

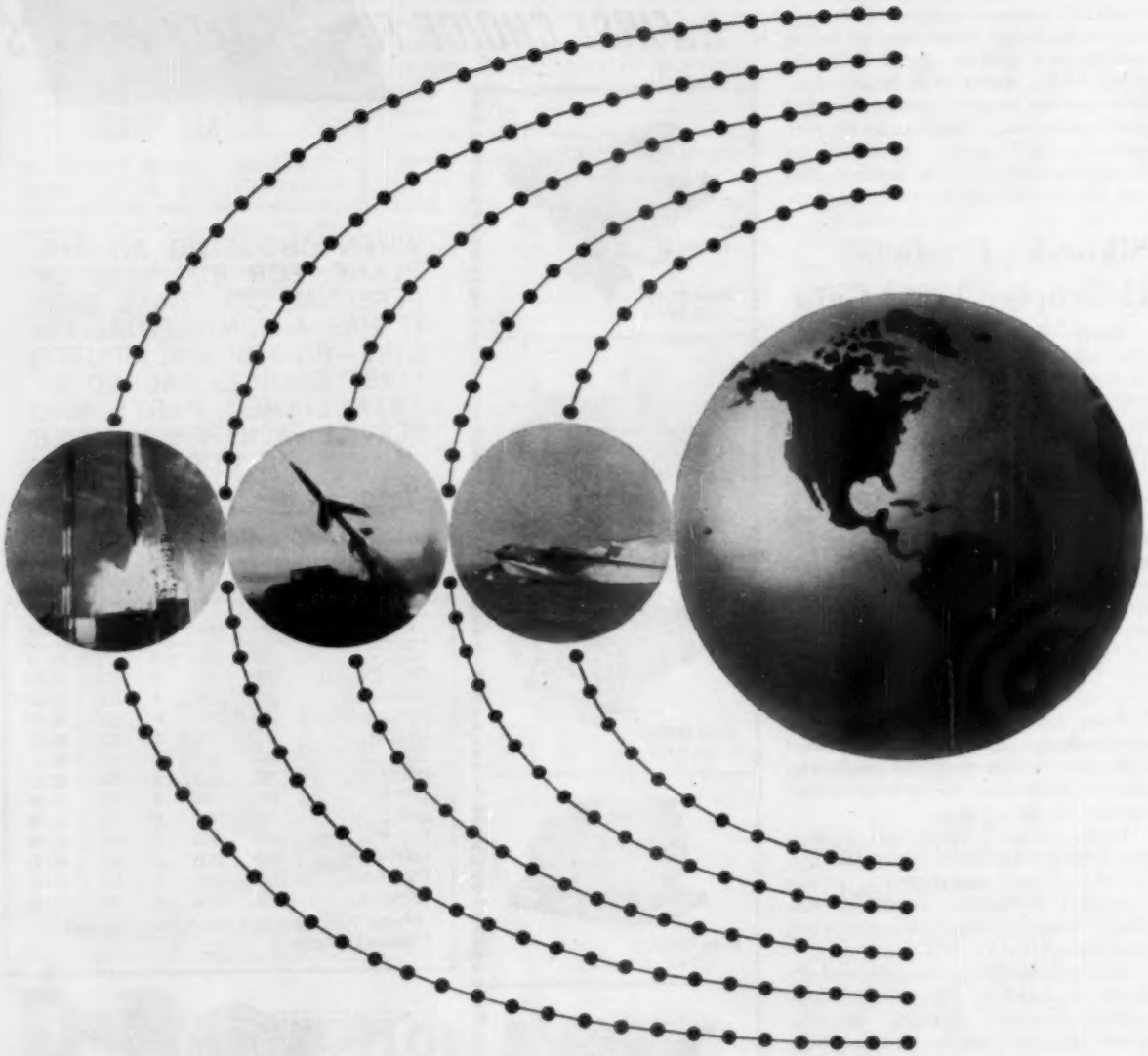
Litton Industries, San Carlos, Calif., tubes, electron, magnetron, type 6510 in a/w spec. MIL-E-1C dated Oct. 3, 1955, supplement 1J dated March 30, 1956 and ISS MIL-E-1/835 (USAF) dated Oct. 28, 1954, S/N 5960-296-2433, PR: MD-8-5960-30573, 1,980 ea., $411,840.

Raytheon Manufacturing Co., Newton, Mass., tube, electron, MIL type 1AD4 in a/w MIL-E-1C dated Oct. 3, 1955, Amendment No. 1 dated April 29, 1957 and ISS MIL-E-1/20C dated June 18, 1957, S/N 5960-188-0829, PR: MD-8-5960-31175, 20,000 ea., $30,000.

CBS-Hytron Division, Columbia Broadcasting System, Inc., Danvers, Mass., tube, electron, type USN 3D21B in a/w Navy spec. MIL-E-1/1132, 5,000 ea.; tube, electron, type 6BQ6GT in a/w spec. MIL-E-1C dated Oct. 3, 1955, Amendment No. 1 dated April 29, 1957 and ISS MIL-E-1/518 dated Oct. 3, 1955, Amendment No. 1 dated April 29, 1957 and ISS MIL-E-1/518 dated Jan. 14, 1954, S/N 5960-262-1302, RFP 33-604-58-1984, 6,600 ea., $46,066.

Eitel-McCullough, Inc., San Bruno, Calif., tube, electron, type 4E27A in a/w spec. MIL-E-1C dated Oct. 3, 1955 and Amendment No. 1 dated April 29, 1957 and ISS MIL-E-1/1038A dated Dec. 4, 1957, S/N 5960-262-1458, 2,700 ea.; tube, electron, type 204TL in a/w spec. MIL-E-1C dated Oct. 3, 1955, Amendment No. 1 dated April 29, 1957 and ISS MIL-E-1/869B dated June 26, 1956, S/N 5960-100-7152, RFP 33-604-58-2342, 1,800 ea., $157,014.

Telectro Industries Corp., Long Island, N. Y., modulator, MD-83A/ARN, S/N 7CAC-5826-090-3683, 248 ea.; maintenance data and engineering data, PR's: MD-8-17C-15608, R55-2115-21609-ASO and R58-90696-20969-E-2-6-ASO, $260,400.



plane and ground. At least once every two minutes, more often if traffic is not heavy, the ground transmitter will interrogate each AGACS-equipped airplane in the area. Ground message always asks for airplane's barometric altitude and may include any one of 32 routine messages that traffic controller wants to send

Such messages normally are addressed to, and received by, only a single airplane. However, messages can be sent simultaneously to all aircraft by means of a "universal address," if desired. Flashing light in cockpit display alerts pilot to new message and he must subsequently push a button to acknowledge receipt so controller knows the message has been read.

Automatic Reply

When the airplane is interrogated, it automatically replies by giving its identification, barometric altitude, plus any routine message or fix report that pilot has set into cockpit controller since last interrogation.

The reply may also include repeat-back of ground message for double-checking purposes.

Total time required to send ground-air interrogation-message and to transmit airplane's reply is 0.24 seconds. Thus 250 aircraft can be serviced per minute on a single frequency. Aircraft are interrogated in a roll call sequence except when the ground controller wants to send a message which goes out on a priority basis in next 0.24 second interval.

AMB flight tests will determine whether AGACS service at intervals of up to once every two minutes (in heavy traffic conditions) is adequate for en route aircraft. If so, a single frequency can serve 500 aircraft. A separate frequency (transmitter) would be used in terminal area to provide more frequent service, perhaps once every 15-30 seconds.

Here are some of the AGACS advantages which will appeal to both pilots and controllers:

• **Reduced cockpit chores.** Automatic reporting of airplane altitude, without any pilot action, and push-button reporting of airplane position fix data should materially decrease flight crew chores.

• **Reduced frequency changing.** Unlike present voice communications, where pilot must frequently change frequencies along the route, it now appears that a single AGACS frequency will handle entire Air Route Traffic Control Center area, and another frequency will suffice for all terminal area functions.

• **Less congestion.** Transmission of routine altitude, fix report information and messages over AGACS is expected to greatly relieve present congestion in radio voice communications, minimizing delay in voice contacts between pilot and controller.

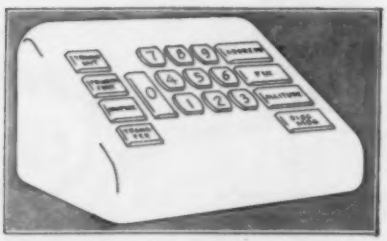
• **Better intelligibility.** Visual display of routine messages via AGACS in both cockpit and traffic control center should ease intelligibility problems which now result from cockpit noise, poor microphone technique and/or foreign language difficulties. The last ground message to aircraft remains displayed on cockpit indicator until updated by new message. Ground controller, upon receipt of new AGACS message from airplane, can call out its previous message from storage to refresh his memory.

• **Direct computer communications.** AGACS "language" is directly compatible with language of traffic control computers which General Precision Laboratory is developing for AMB. This means that routine airplane altitude and fix reports can go directly into computer without human intervention and the resultant risk of error. The computer will examine latest altitude/fix report, compare it with last previous report and estimated time of arrival over fix. If there is no serious discrepancy, the computer will print out the fix arrival information on controller's flight progress strip. If there is any significant deviation, computer will flash warning light on controller's console alongside flight strip of appropriate aircraft. Controller can then push button to display latest aircraft report and decide what action should be taken.

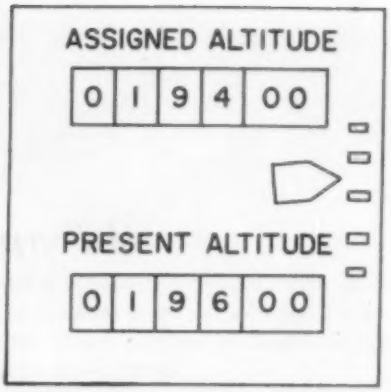
The AMB/RCA system is designed to work with existing airborne VHF communications receivers and transmitters built to Arinc specs, and with recent vintage military UHF equipments. AMB also wants to evaluate feasibility of using AGACS with high frequency (HF) equipment for long-distance operations and has asked RCA to design experimental system to permit operation at slower data rate.

One of two communications equipments carried by an airliner would normally be assigned for AGACS use, the other for voice. However, unit operating with AGACS is instantly available for voice use if needed.

To equip an airplane for AGACS will involve addition of a data processing unit and cockpit display. Engineering models which RCA is scheduled to deliver for flight tests in fall of 1960 are expected to weigh about 40-50 lb. If past experience is any criteria, some size, weight reductions should be possible in ultimate production equipment. Smaller, lighter, less sophisticated AGACS units should also be possible for smaller aircraft.



GROUND controller will compose AGACS message using same handset by which he communicates with traffic computer being developed by General Precision Laboratory.



COCKPIT instrument displays assigned altitude transmitted via AGACS and actual airplane altitude. Needle indicates that the airplane should climb.

Error Prevention

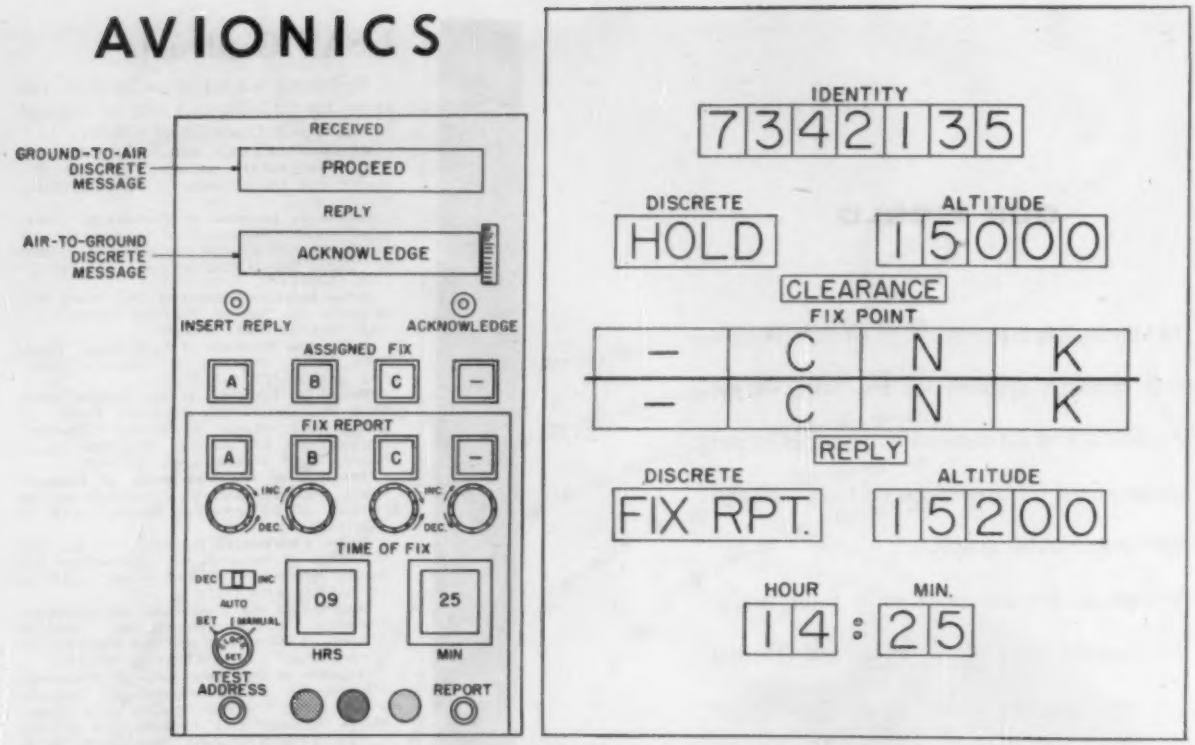
Many potential advantages of AGACS cannot be realized unless system can be made extremely reliable and error-free. This is more difficult for AGACS than for voice communications because of the considerable inherent redundance that exists in human language.

An AGACS message consists of several groups of pulses. One group, for example, carries the identification (address) of the airplane to which message is directed. Another group of pulses indicates which one of the 32 routine messages is being sent.

If one of the pulses in the address group should be "lost," because of propagation or other difficulties, it could change the address from the intended airplane "A" to an address corresponding to airplane "B." If airplane "B" also happens to be flying in the same area, then the message intended for "A" will be displayed in the cockpit of "B." If the loss of a pulse occurs in the group which carries the routine message, an incorrect message could be displayed.

Fortunately, many random errors would immediately be obvious to the pilot, traffic controller or traffic computer on the ground. For example, a pilot of a DC-3 cruising at 10,000 ft. would immediately suspect an AGACS message which instructed him to climb to 40,000 ft.

Similarly, the traffic computer on the ground would detect that something



COCKPIT controller (left) will display AGACS messages received from the ground, also will be used by pilot to send fix reports and routine messages. Layout shown is for experimental evaluation tests. At right, ground controller's display shows airplanes last fix report and message that controller wishes to transmit to airplane. Controller checks message here before sending it.

AGACS Data Link Eases Pilot Chores

By Philip J. Klass

Washington—Work has begun on a system that is expected to provide the most significant improvement in air-ground communications since the introduction of two-way radio several decades ago.

The development bears the unwieldy name of Automatic Ground-Air-Ground Communication System, abbreviated AGACS with one of the "Gs" missing so it can be pronounced "Ajax." When the concept was first proposed more than a decade ago, it was called Air Traffic Control Signaling System (ATCSS) and similar military systems are called "data link."

AGACS is being developed by Radio Corp. of America's Defense Electronic Products Division under Airways Modernization Board sponsorship (AW June 30, p. 19). System will use many of the techniques developed by RCA for the new data link system it is designing for Air Force and Navy. Experimental system is slated to be delivered to the AMB for flight test evaluation in August, 1959.

Highlight Features

AGACS will provide three types of service without requiring use of conventional voice radio:

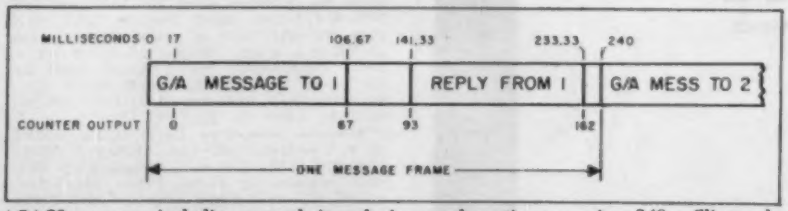
• **Automatic altitude reporting.** Every airplane will automatically report its barometric altitude at frequent intervals to ground traffic control centers without requiring any action by pilots or controllers. Altitude reports will be made at least every two minutes, more frequently if traffic is light.

• **Semi-automatic fix reporting.** Once the pilot has pre-set identification of the next en route fix into his cockpit controller, he need only push a single button as airplane arrives at fix to transmit airplane identification, fix identification, time and airplane altitude to ground traffic controller and traffic control computer. Eventually, when airborne auto-navigators come into use, position reporting could be continuous and automatic.

• **Routine message exchange.** Pilot and/or controller can transmit choice of 32 different routine messages to the other. Typical controller-to-pilot messages might include: "Descend to 12,000 ft." or "Hold at Fix XYZ." Representative pilot-to-controller messages might be: "Request higher altitude." (Selection of the most-frequently used routine messages is under AMB study. Initial selection can be easily changed if operating conditions require it).

AGACS is intended to relieve present voice communications, not replace it. Voice will be used for non-routine and emergency messages.

AGACS is a digital communication system whose messages consist of short bursts of pulses exchanged between air-



AGACS message, including ground-air and air-ground portions, requires 240 milliseconds.

Advanced missile and space projects

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THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as the Navy Polaris IRBM, Earth Satellite, Kingfisher (Q-5) target missile for the Army and the X-7 ramjet test vehicle for the Air Force.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. High-level engineers and scientists are needed now for responsible positions in our Research and Development laboratories and in our project organizations.

If you are experienced in physics; mathematics; chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 2, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.)

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TECHNOLOGY

FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry.

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight—water, air and outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

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The Lockheed Kingfisher Q-5 is the nation's fastest target missile, developed for the Air Force to test the accuracy of our newest supersonic weapons.

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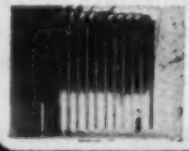

Photo shows exhaust end of Acou-STACK installation in the Lewis Unitary Wind Tunnel.

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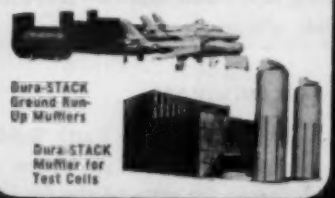

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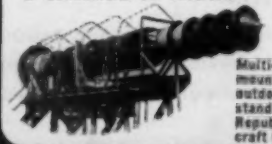

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was wrong if it received an AGACS message from airplane known to be flying from New York to Washington which reported the airplane over a fix near Denver, or that the airplane had changed altitude from 10,000 ft. to 25,000 ft. in the two minutes elapsed since the last report. Such discrepancy will cause computer to flash a warning light on controller's console, opposite appropriate flight progress strip.

Built-In Checks

In many instances, loss of one or more pulses in a message group will produce so illogical a message that an error will be obvious. But RCA will employ other techniques to minimize possibility of error. For example, unless an airplane is making one of its infrequency fix reports via AGACS, the aircraft reply will include in addition to its identification a report-back on the last message and assigned altitude it received from the ground. Repeat-back is automatically checked by ground equipment against original message for correctness.

If repeat-back is incorrect, AGACS automatically transmits the original message again, once more compares the airplane reply with the original. If four successive attempts fail to obtain correct repeatback, the system automatically flashes warning light on controller's console, opposite appropriate flight progress strip.

Another technique that will be used is called "parity check," similar to one employed in digital computers to prevent errors due to loss of pulses or pick-up of spurious pulses. In technique known as odd-parity check, the total of pulses in each group is made equal to an odd-number, by adding an extra pulse if necessary, before message is transmitted.

When a message is received at other terminus, the group of pulses is examined automatically to determine if total is an odd-number. If not, the message is rejected as being in error. The even-parity check operates similarly except that total number of pulses is made equal to an even-number and checked accordingly upon receipt. RCA plans to use odd-parity check for several of the message groups, even-parity check for others.

Both airborne and ground-based portions of AGACS will have number of other fail-safe type features. For example, test signal transmitted every 30 seconds by ground transmitter makes it possible for pilot to check performance of his airborne unit. By depressing test button, cockpit indicator should display symbols which identify AGACS station to which equipment is tuned, if airborne unit is operating satisfactorily.

Each airplane normally should receive grouped interrogration at least once every two minutes. The airborne unit will incorporate a timing mechanism which will flash warning light for the pilot in event that it has not received a group interrogation for three minutes (or other interval established during initial flight evaluation).

A similar timing device will flash warning light if modulation sidetone from ground transmitter has not been received for a period of five minutes, indicating possible shutdown of ground equipment or other basic failure.

If the ground station fails to receive an altitude report from an AGACS-equipped airplane on its rolls, it does not run through its roll call before trying again. Attempt is made to interrogate the same airplane 15 seconds later. If no reply is forthcoming, still another is made 15 seconds later. (Failure to receive reply might be due to airplane being in a turn and its antenna being shielded by portions of airframe). If contact cannot be established, AGACS automatically flashes warning light to the controller opposite appropriate flight strip. The controller may then use voice radio to try to establish contact.

Ground-to-air message, composed by traffic controller using the same hand-set employed to enter data into General Precision Laboratory computer, will be displayed to the controller before being transmitted to the aircraft. After checking corrections of the message, controller will push a button to transmit message in next time slot.

Technical Details

Here are some of the technical details on the AGACS system which RCA will design:

- **Type.** Time-division multiplex, capable of operation of single-channel simplex or double-channel simplex. Time-division multiplex means that the messages to different aircraft are separated by a time interval in a roll call sequence, rather than simultaneous transmission to several aircraft on different frequencies as in frequency-division multiplex—technique employed in existing Air Force data link.
- **Data rate.** 750 bits per second for VHF, UHF operation. Data rate of 10 bits per second will be evaluated experimentally for HF operation.
- **Message length.** 80 bits for ground-air message; 69 bits for air-ground.
- **Message round.** Time required for transmission of ground-air message and air-ground reply will be approximately 0.24 seconds.
- **Interrogation rate.** 250 per minute per channel.

In its proposal, RCA recommended use of frequency shift keying (FSK) as the best modulation techniques for assuring reliable, interference-free AGACS operation. With FSK modulation, carrier frequency is shifted 12 kc. in one

direction to produce one of the two binary numbers ("00," "1") that make up AGACS digital code, and shifted 12 kc. in opposite direction to produce the other. For UHF operation, FSK shift will be 20 kc., unless UHF channeling is reduced to 50 kc., in which case a 12 kc. shift would be used.

FSK modulation theoretically opens the way to simultaneous transmission of both AGACS and voice on a single frequency. However, some problems must be solved before this becomes an operating reality.

After consulting with Air Transport Assn. and Aeronautical Radio Inc. engineers, AMB concluded that a pure-FSK modulation system might require extensive modification of existing airline and business aircraft receivers-transmitters for AGACS use. For this reason, AMB has asked RCA to study the problem and come up with an alternate modulation system which can be tried out, alongside FSK, in experimental system.

One possible alternative is the use of tone-shift modulation in which the carrier is modulated by one audiotone to transmit one binary number, modulated by a different tone to transmit the other. Another possibility is to use phase modulation in which phase of a 750 cycle tone is reversed. This modulation technique would permit use of coherent detection with improved signal-to-noise ratio.

There is considerable disagreement over the merits of different modulation techniques, according to Wayman Deal, AGACS project engineer at AMB. One of the objectives of AMB tests next summer will be to evaluate the practical advantages and disadvantages of pure-FSK and the alternative modulation technique which RCA develops, under actual operating conditions.

Experimental equipment which RCA will deliver next summer will first be tested to prove out fundamentals of the AGACS system. Initially, equipment will not be tied in with General Precision Laboratory's control computer and data processing equipment, until each system is debugged.

Once this is accomplished, marriage of the two systems will be next major objective, because each leans heavily upon the other to achieve many of its potential features. For example, the GPL data processing system will use automatic altitude, six reports provided by AGACS to update its information on each airplane and to help determine when airplane is deviating from assigned flight plan or coming into conflict with another aircraft.

Similarly, AGACS will depend upon GPL computer to verify validity of individual airplane report by comparing it with the previous report or computer predicted position of airplane.

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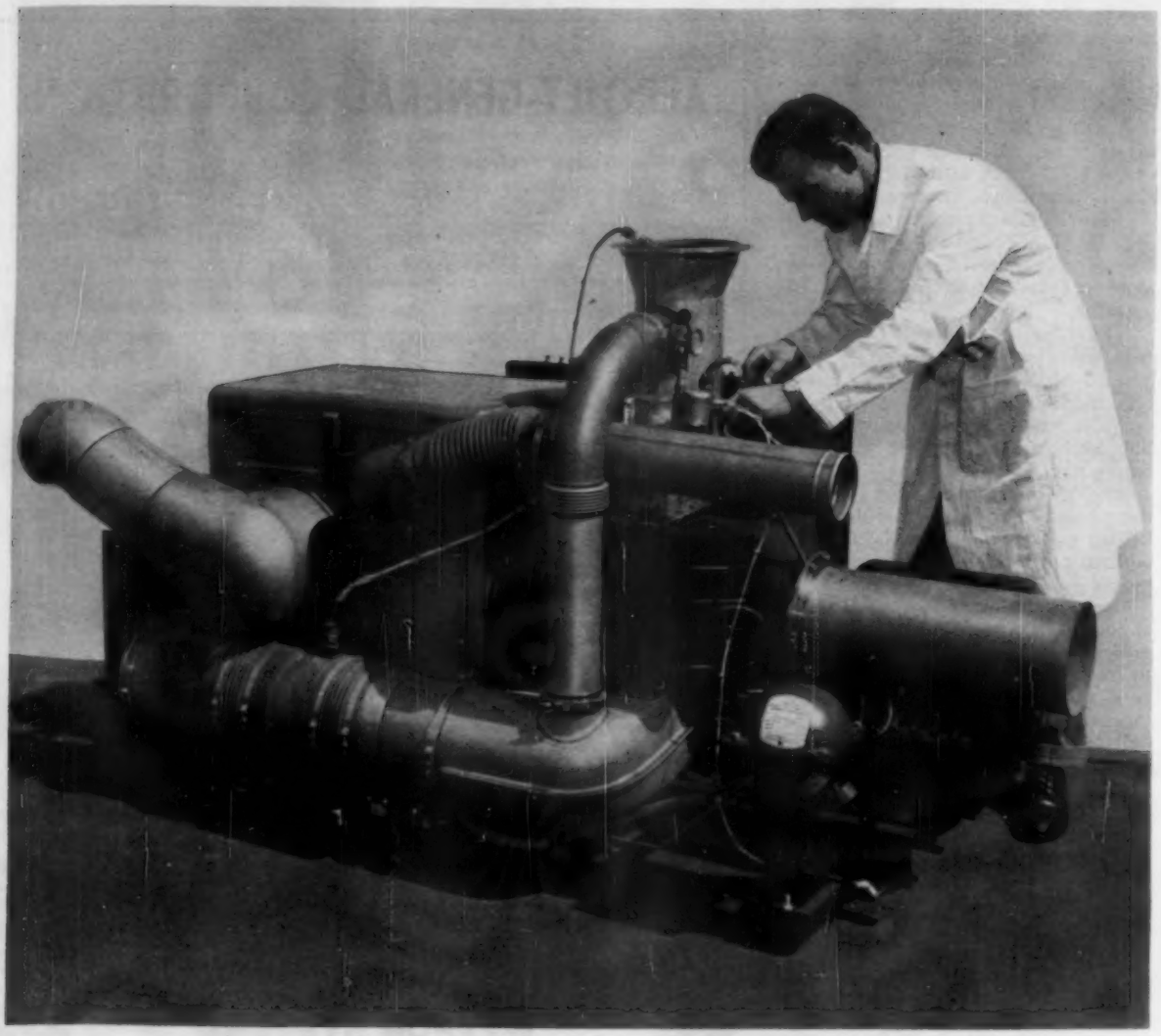

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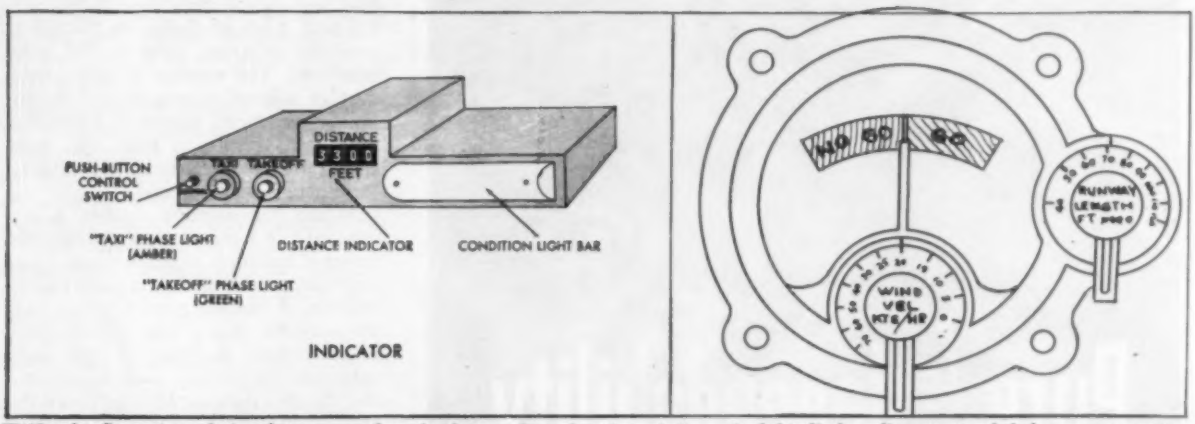


TWO takeoff monitors designed to warn pilot of sub-normal accelera tion. Avien unit (left) displays distance traveled down runway, uses green or red light to show takeoff status. Doman unit (right) uses pointer to display status on continuous basis.

Takeoff Monitors Compete for Market

Washington—Two new takeoff monitors, designed to warn the pilot when his takeoff run is sub-normal in time for a safe abort, have been disclosed by Avien, Inc., and Doman Helicopters, Inc.

Both monitors are airborne types, intended for aircraft installation. They bring the total of such takeoff monitors known to be under development to five, including units by Kollsman Instrument, Minneapolis-Honeywell and Sperry Gyroscope described earlier (AW June 23, p. 65). A ground-based takeoff monitor also has been proposed by Northrop Aircraft's Nortronics Division.

Highlights of the two new entries, both entering flight test phase, include:

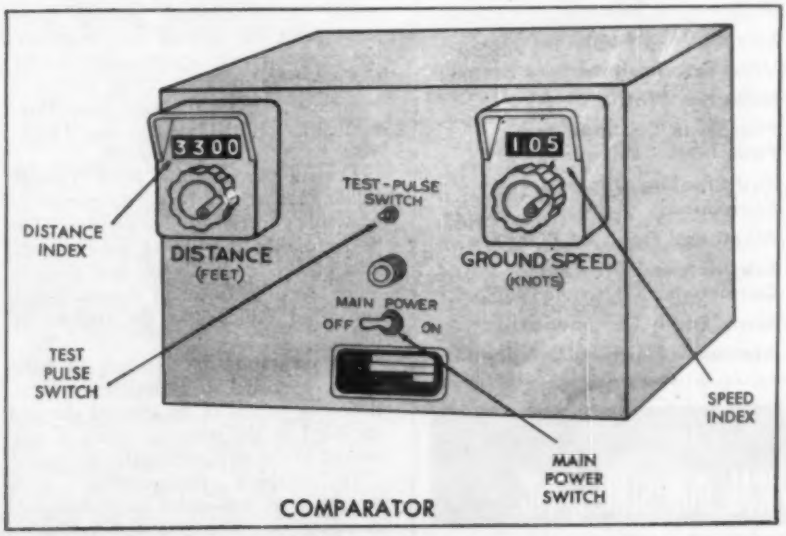
• **Avien takeoff monitor** continuously measures distance airplane has traveled down the runway, determines airplane's ground speed. At a pre-selected distance, monitor compares actual ground speed with pre-set value which craft should have achieved. If the airplane's speed is too low, the monitor automatically flashes a red light on cockpit indicator.

• **Doman takeoff monitor** measures airplane ground speed, computes its acceleration and compares this with "normal" value which airplane should achieve. Cockpit indicator gives the pilot a continuous indication of whether acceleration is above or below normal. Automatic alarm can be provided if desired.

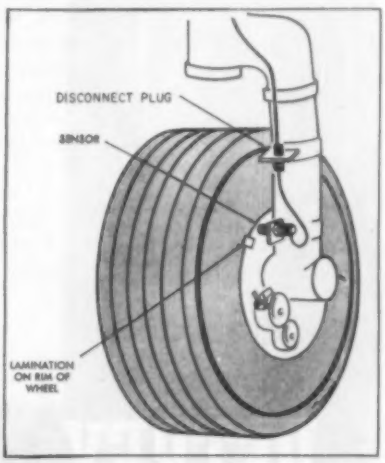
Avien's monitor, weighing about 5 lb., is essentially a mechanized version of the manual line-check procedure now used by military jet pilots. This is to compute what speed the airplane should reach at pre-selected point along runway, using charts which take account of such factors as weight, temperature, barometric pressure. During takeoff run, the pilot compares airspeed indicator reading with pre-computed value as his airplane passes check point marker along runway.

Avien's monitor is based on using same charts and procedure, but the pilot sets required airspeed and check-point distance into the device before takeoff. He is relieved of having to look for a check-point marker outside the cockpit, reading the airspeed indicator and making comparison with pre-computed speed required at that point.

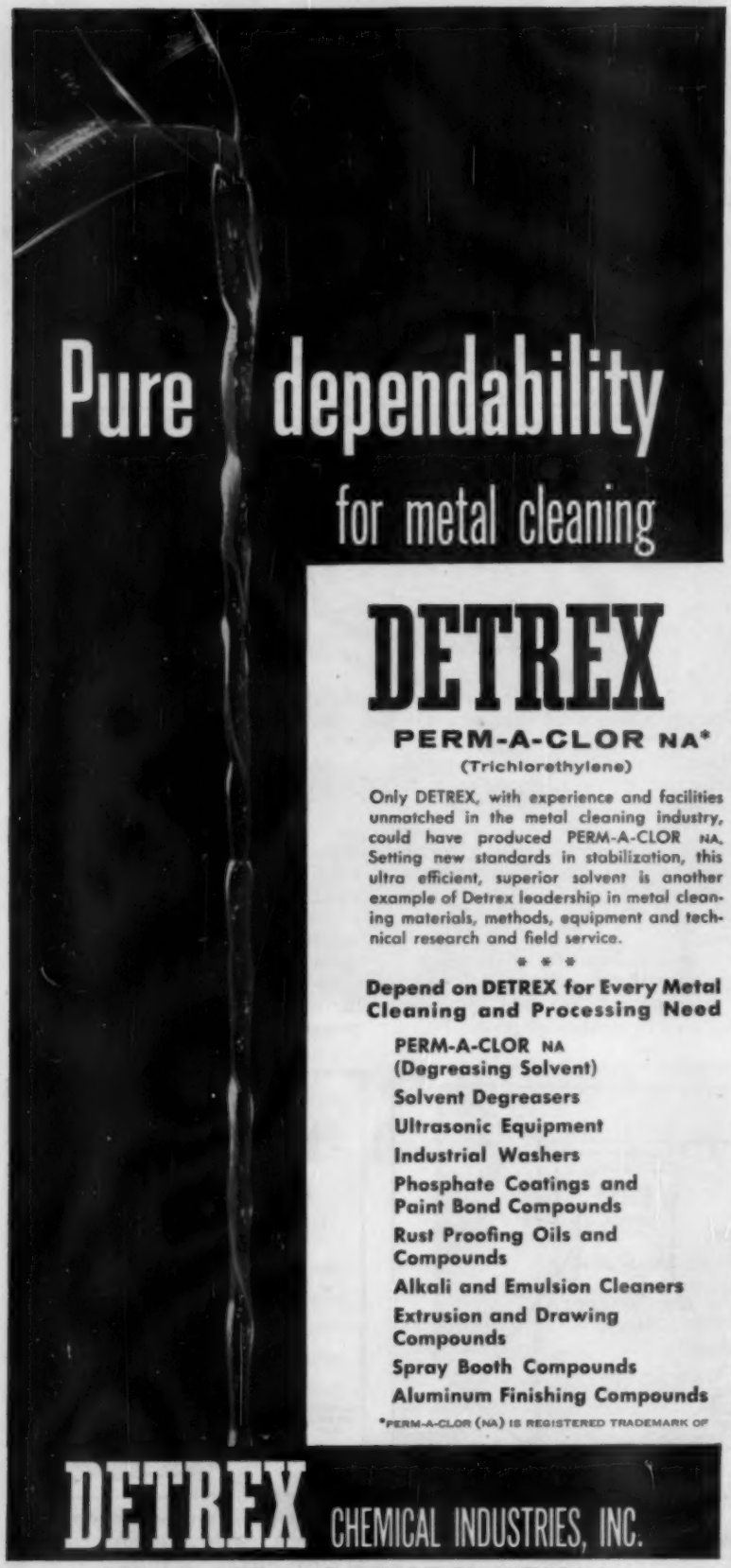
To measure distance traveled down the runway, Avien uses a small pulse generator attached to main landing



COMPARATOR sets in pre-computed check point distance and speed in Avien monitor.



AVIEN measures airplane ground speed by means of a small sensor on main gear which generates pulse each time metal tab on rim of tire rotates past sensor.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gear and small ferrous armature on tire rim. Each revolution of the wheel produces electrical pulse in the pulse generator. The number of pulses from start of take off is proportional to distance covered. By process of differentiation with respect to time, the pulse count also provides signal proportional to airplane ground speed.

When the airplane reaches a preselected check-point along runway, the monitor compares airplane speed signal with voltage obtained from pre-set speed selector. A flashing green light on cockpit indicator shows that aircraft speed is satisfactory, flashing red light indicates speed is too low; cockpit indicator also displays distance traveled down the runway during take-off run by means of digital counters.

Avien system enables the pilot to check out certain portions of the monitor's circuitry prior to takeoff, by either of two means:

- **Pushing "taxi" button** prior to start or taxiing causes cockpit distance counters to advance as aircraft moves into position, checking operation of wheel pick-off and certain other circuits.
- **Pushing "test" button** on controller produces signal equivalent to one rotation of main wheel. Pilot can push test button prescribed number of times and check whether corresponding distance indication appears.

When the pilot is ready to begin actual take-off roll, he pushes the "Take-off" button cockpit indicator. This operation could be performed automatically by tieing it in with release of brakes or advancing of throttles.

With present Avien design, the pilot gets no advance indication of how aircraft is accelerating until he reaches preselected check-point. However, a company spokesman says that the device has all the necessary input information to permit a continuous comparison of actual versus desired ground speed throughout the take-off run, if desired. Some additional complexity would, however, be involved. The system is completely transistorized, uses three transistors. Both 28 v.d.c. and 115 v., 400 cps. power are required.

Doman Acceleration Rate Takeoff, called "Darto," is being developed by company's special devices division. The device avoids the use of pre-computation charts or slide-rules, but does require the pilot to set in runway length and wind velocity on the cockpit indicator.

Compensation for changes in barometric pressure is automatically introduced by means of an aneroid element included in the monitor which is connected to the airplane's static air source.

In simplest configuration, gross weight does not enter into monitor's computation. The system is calibrated to provide safe margin for maximum air-

craft gross weight, according to Doman's John Mazur. In a more deluxe version, airplane gross weight would be set in.

Doman will not disclose the means used to measure airplane during speed takeoff run, except to say that it measures ground speed. Airplane acceleration is obtained by differentiating the speed signal, using a resistor-capacitor network. Correction is provided to automatically compensate for slight drop-off in airplane acceleration as it picks up speed.

Cockpit indicator is a "go" "no-go" type indicator with a pointer that shows how actual aircraft acceleration compares with value required for safe takeoff. Automatic alarm provision is optional.

FILTER CENTER

▶ **Test Labs Hard Hit**—Tremendous expansion of facilities and manpower for testing avionic component reliability during past year or two by both independent testing laboratories and avionic equipment manufacturers appears to have gone beyond current needs. Equipment makers are pulling back more testing work into own facilities and many are seeking outside testing work to keep their own facilities busy, striking a double blow at the independent testing laboratories.

▶ **Transistors vs. Tubes**—Although industry produced 17 times as many receiving tubes as it did transistors during first five months of 1958, total factory price of the tubes was less than four times that of total transistors, reflecting the latter's higher unit cost. Average price for the 154,000,000 tubes is 87 cents, compared to $3.85 average unit price for the 8.9 million transistors.

▶ **Components for Space**—"New Concepts for Space Age" will be the theme of the 1959 Electronic Components Conference to be held May 6-8 at Benjamin Franklin Hotel in Philadelphia. Papers are being sought on such subjects as components and their application in space vehicles, micro-miniaturization and the new Micro-Module component. Prospective authors should submit 150-200 word abstracts by Oct. 1 to Brig. Gen. Edwin R. Petzing, AGEP Secretariat, University of Pennsylvania, 200 So. 33rd St., Philadelphia 4, Pa.

▶ **New Semiconductor Standard**—Proposed new military specification on semiconductor devices, MIL-S-19500B, prepared by Armed Services Electro-Standards Agency (ASESA) has been submitted to industry for comments.

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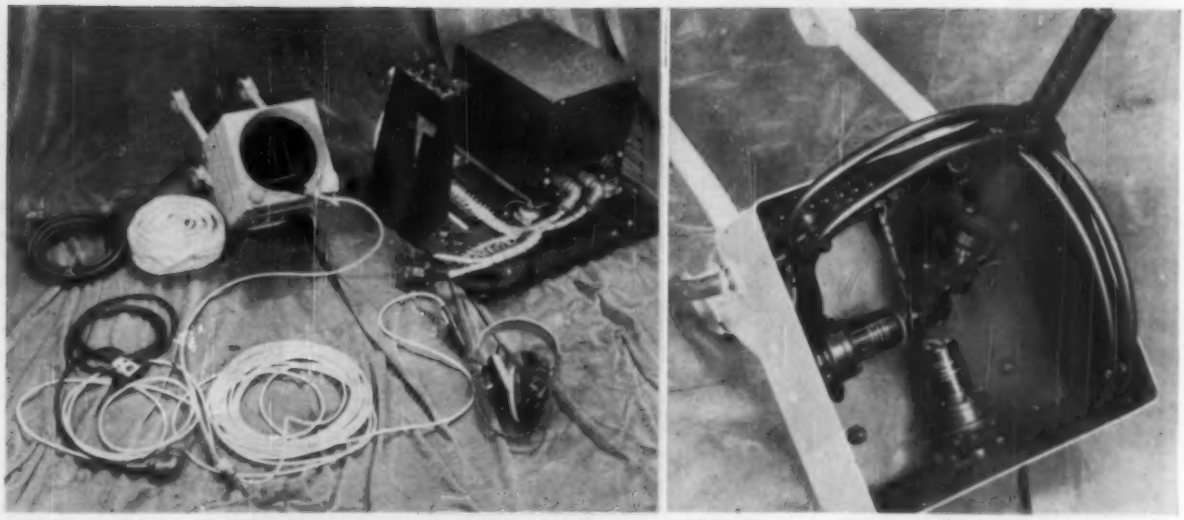


TETHER ground control sensing unit is connected to cable (left); black box is coupler. Unit (right) has two pick-off synchros.

Tethered Helicopter Under Evaluation

Stratford, Conn.—Evaluation of an electronic device which allows a man on the ground to lead a flying helicopter by a 50-ft. tether will be conducted by the U. S. Marine Corps on HUS-1, military version of Sikorsky S-58.

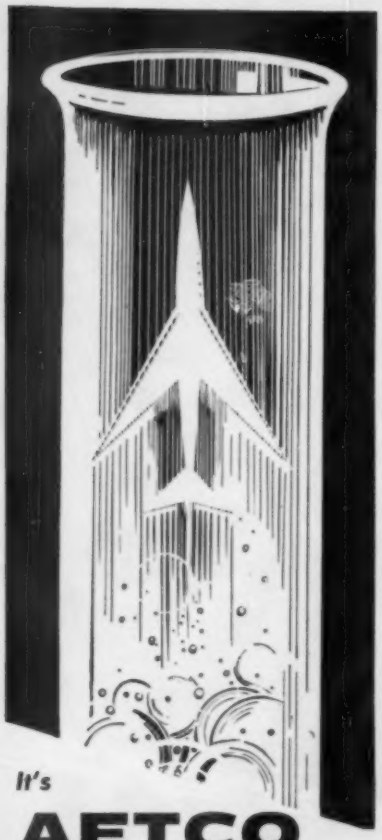
Tether system, developed by Sikorsky Division of United Aircraft Corp., previously was evaluated by U. S. Army Aviation Board at Fort Rucker, Ala., using an H-34 helicopter. Army may order two tethers for research. Another system involving remote control and a halter, has been developed by Kaman Aircraft Corp.

The equipment takes over complete control of an airborne helicopter from the pilot. Aircraft responds to tension and motion on a cable (or tether) hanging down from the side of the cabin. The helicopter will change altitude or position as fast and as accurately as the ground operator's signals order.

Sikorsky cites the following advantages:

- **Aid in hooking up loads** to be carried in helicopter's cargo sling, since pilot's cabin visibility is restricted in downward view. Ground operator can guide aircraft to the load, maintain constant altitude while another man hooks up the sling.
- **Low visibility operations,** such as blacked-out combat operations or landings in dusty or snow areas where helicopter rotor blades cause ground disturbance. Sikorsky also says the tether system is valuable on shipboard heliplatforms during sea stage conditions.
- **Ground operator** does not have to

GROUND operator maneuvers helicopter with cable attached to control unit (above door).



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be a pilot. Engineers claim inexperienced man can be taught to operate the system in a matter of two hours.

• **Tether will facilitate aerial crane operations**, such as lowering high tension power line towers, temporary bridges or placing utility poles.

System utilizes Sikorsky Automatic Stabilization Equipment (ASE) and a tether coupler, essentially an electronic sensing device. The pilot brings his aircraft to hover position at about 50 ft. altitude, trims it with ASE, engages the coupler and lowers the cable to ground operator.

In an emergency, the pilot can override the automatic control.

One end of the tether is connected to a sensing unit attached to the rescue hoist mount located on the right side of the cabin above the cargo door. When the pilot engages the coupler, two lights on the bottom of the sensing device go on, informing ground crew the tether is activated. Movement of the tether is detected by sensing device which then feeds signals to the coupler. Coupler, in turn, transmits signals to the ASE system.

Packaged Test Units Mounted on Casters

Los Angeles—Packaged environmental testing laboratory developed by Mantec, Inc., El Segundo, Calif. has been delivered to Ratigan Electronics, Glendale, Calif. Package includes a humidity-temperature test chamber with a built-in electromechanical vibrator; a combination high-low temperature and altitude test chamber; a shock test machine, and two high-low temperature test chambers. All chambers are the same height, have the same finish and are approximately the same length and depth. All test areas are approximately 5 cu. ft. Mounted on casters, the chambers can readily be arranged in a desired order indicated by a particular testing cycle.

Temperature-humidity-vibration unit has an automatic programmer which can be set to provide various environments in combinations and sequences. Programmer will automatically repeat test cycles as often as required. Automatic recording equipment is provided. Altitude-temperature chamber and the two temperature chambers have interchangeable "plug-in" type specimen mounting panels, so that specimens can be moved from one test to another without delay. Spare panels are provided for mounting new specimens while previous ones are tested.

Altitude plenum of the altitude-temperature chamber can be removed and operated separately or in one of the other temperature chambers.

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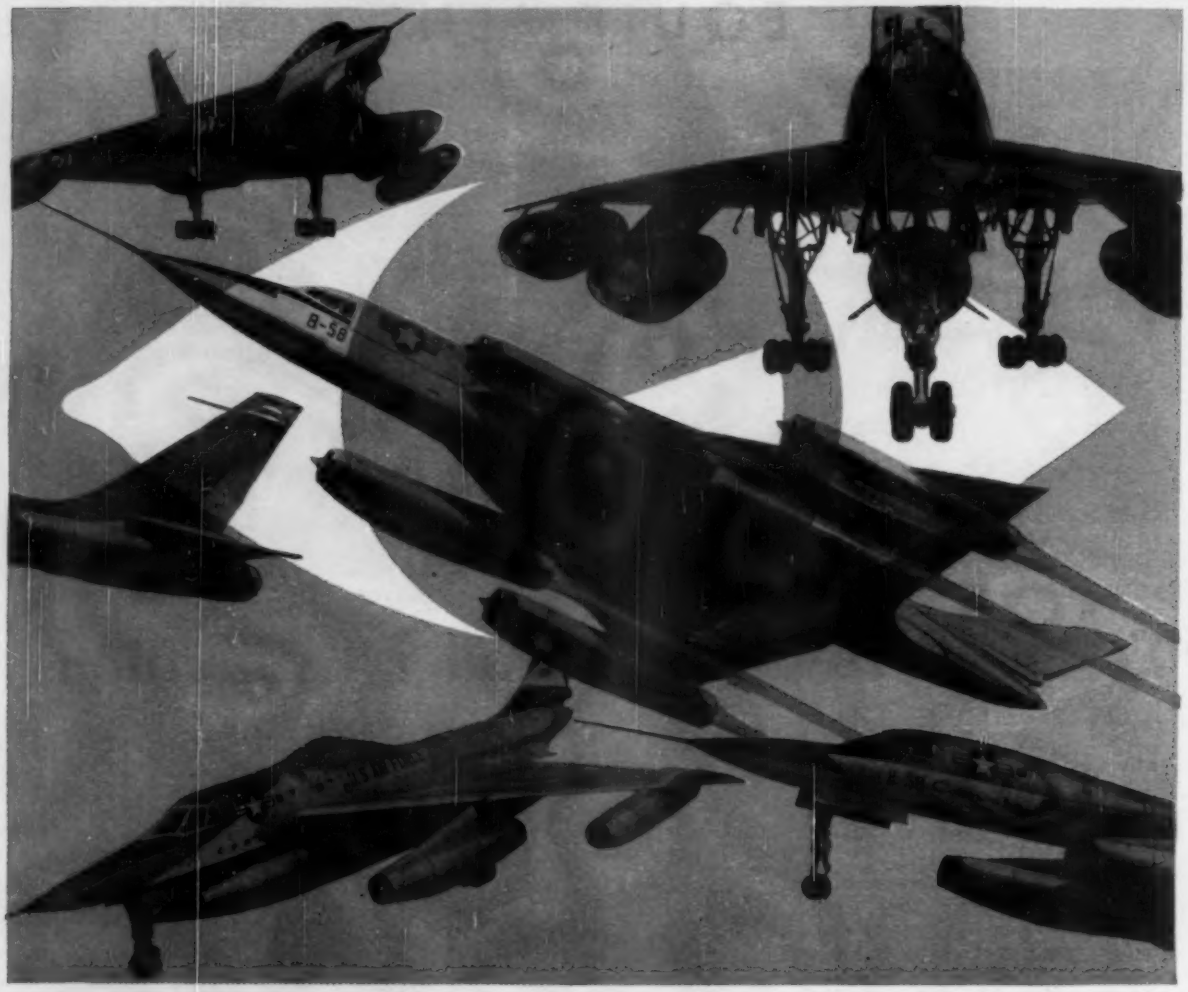

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Throughout the design stages of the B-58 . . . and in the conception of every one of the more than half-a-hundred Air Force projects now on hand . . . one major consideration is *Growth Potential* . . . the weapon must fly even faster, farther, safer tomorrow than it does today!

Growth potential of a weapons system results directly from growth potential for the individual engineer. If professional growth is a condition of your career plans, send a confidential resume of your training and experience for consideration *by engineers* in the area most suited to your qualifications. For personalized handling address your inquiry to P. O. Box 748A.

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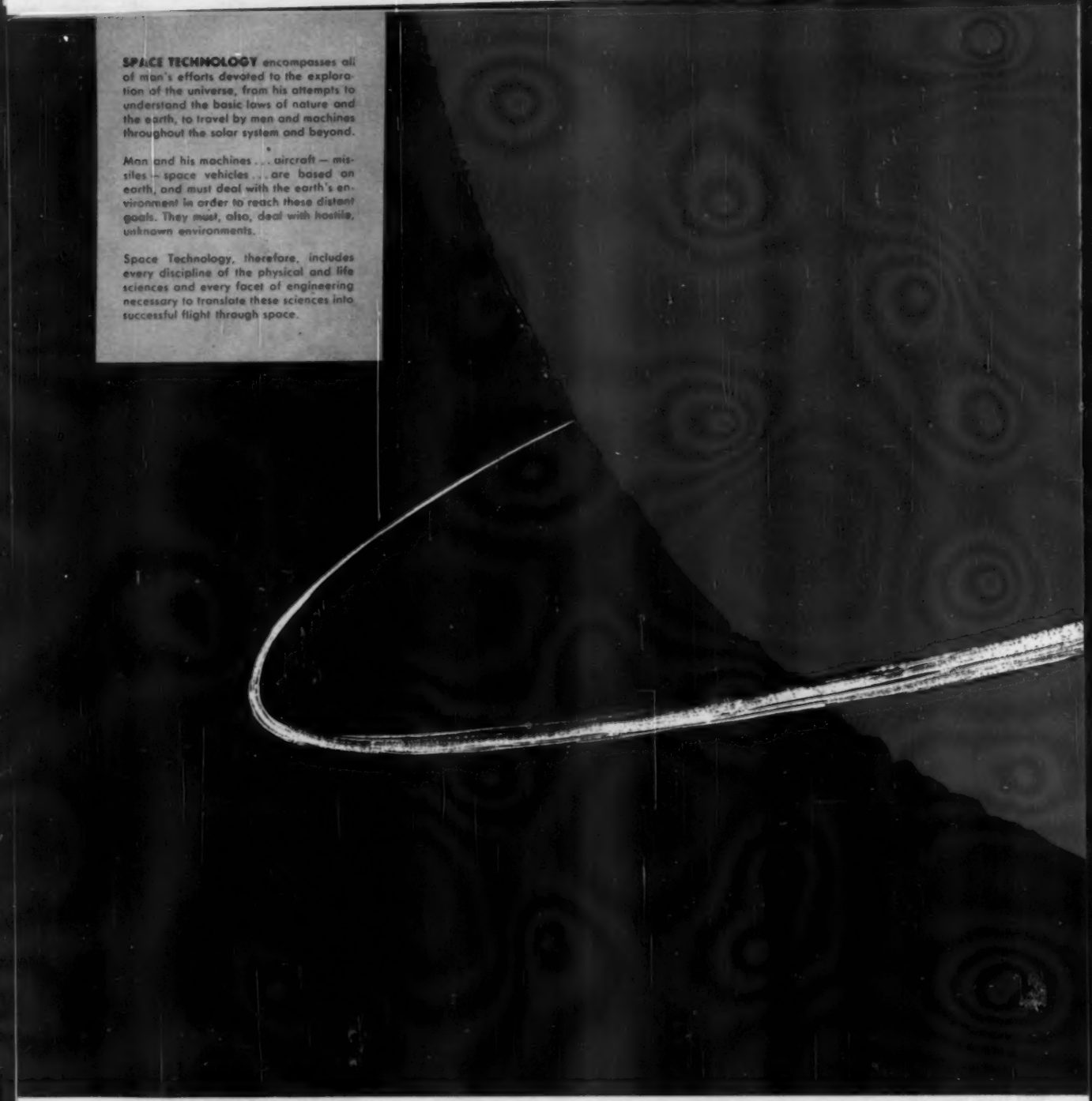


SPACE TECHNOLOGY encompasses all of man's efforts devoted to the exploration of the universe, from his attempts to understand the basic laws of nature and the earth, to travel by men and machines throughout the solar system and beyond.

Man and his machines . . . aircraft — missiles — space vehicles . . . are based on earth, and must deal with the earth's environment in order to reach these distant goals. They must, also, deal with hostile, unknown environments.

Space Technology, therefore, includes every discipline of the physical and life sciences and every facet of engineering necessary to translate these sciences into successful flight through space.

LUNAR PROBES • • • will precede man in our race to the moon. These instrumented vehicles will be hurled from the surface of the earth by multi-stage rockets — some to reach the moon, others to circle it.

AVIATION WEEK readers have been able to follow week-by-week developments of lunar probes. When the first attempt is made, AVIATION WEEK editors will also cover every technical aspect of that story. To the influential AVIATION WEEK engineering-management-military audience, they will bring authoritative, history-

to be constructed in the past, the manufacturer states.

Hille-Form fixture adjusts in a few minutes and locks into position around component. Ground handling unit is said to overcome the obsolescence factor in single purpose pieces of equipment.

Associated Suppliers Co., 2425 San Fernando Rd., Los Angeles 65, Calif.

WHAT'S NEW

Publications Received:

Space Flight by Carsbie C. Adams, President, National Research and Development Corp., Atlanta, Georgia—pub. by McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York 36, N. Y. $6.50, 392pp.

A survey of the past, present and future of space travel written in a way that should prove interesting and informative to general as well as to technical readers. It discusses all important recent advances, and provides the reader with details on astronautical projects.

Basic Aeronautical Science and Principles of Flight—by Robert D. Blacker; pub. by American Technical Society, 848 East 58th Street, Chicago 37, Illinois. $5.95, 243pp.

The purpose of this book is to supply a background in aeronautics for those having an interest in aviation whether business or personal. It is easy to understand; book contains illustrated explanations of the fundamental laws of the physical universe which are necessary to know how to understand aeronautics and the principles of flight.

Atlas of the Sky—by Vincent de Callatay—Pub. St. Martin's Press Inc., 103 Park Avenue, New York 17, N. Y. $12.50; 157 pp.

This book would interest any astronomer. It has explicit drawings of the different planets, and contains a listing of the constellations by plates.

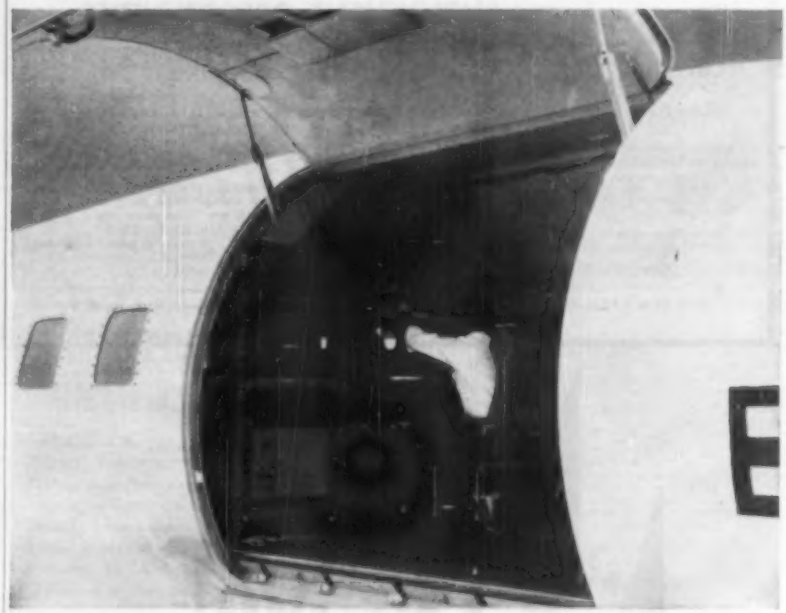
Graf Zeppelin—by J. Gordon Vaeth—Pub. Harper & Brothers, 49 East 33 Street, New York 16, N. Y. $4.00; 235pp.

The biography of the Zeppelin and of its commander Dr. Hugo Eckener, and also the important part both played in history.

Spacepower—by Donald Cox and Michael Stoiko, published by The John C. Winston Co., 1010 Arch Street, Philadelphia 7, Pa. $4.50, 262 pp.

This book analyzes the social, military and legal aspects of space penetration, probing the human wants, needs, hopes and problems in the fantastic new world man is building for himself.

ENGINEER OPPORTUNITIES AT RAYTHEON



DOPPLER NAVIGATION EQUIPMENT is readied for flight testing under operational conditions. Engineers at the Maynard Laboratory hold responsibility for program from initial study phase through prototype production.

Newly formed project groups solve complex airborne radar problems

Engineers like the project-type organization at Raytheon's Maynard Laboratory. It gives them maximum diversification in their work on the most advanced radar navigational and control problems of the day.

At Maynard, you'll find projects involving many areas of aircraft navigation and guidance systems . . . doppler navigation, velocity check systems, night-fighter operations systems, flight-control systems, altimeters. There is also interesting new work on countermeasures equipment.

Career opportunities for men at all levels now exist in the following areas:

MICROWAVE COMPONENT DESIGN
ANTENNA DESIGN
ELECTRONIC PACKAGING
SYSTEMS ANALYSIS & ENGINEERING
TECHNICAL WRITING
SPECIFICATIONS WRITING
ADVANCED CIRCUIT DESIGN

For complete details on engineering positions in any of Maynard's project groups, please write John J. Oliver, P.O. Box 87 A, Raytheon Maynard Laboratory, Maynard, Mass.

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Maynard, Massachusetts

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Excellence in Electronics

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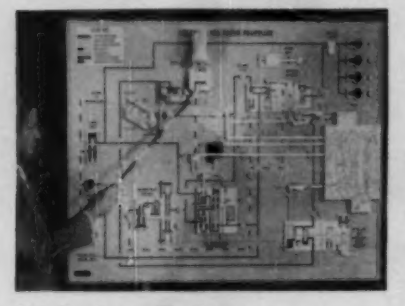


Jet Systems Trainers

Systems trainers are designed to aid flight crews and maintenance personnel in learning aircraft systems of Boeing 707 and Lockheed Electra transports. Modular cell construction, permitting technical modification in the systems to be incorporated on the panel, reduces the obsolescence factor, the maker states.

Panels are available for 31 different aircraft systems including hydraulic, spoilers and ailerons, elevators, flaps, fuel, air-conditioning, pressurization, landing gear and turbo-propeller systems.

Burton-Rodgers, Inc., 8106 E. Admiral Pl., Tulsa, Okla.

Fuming Nitric Acid Valve

Valve is designed for use with helium and JP-4 fuel vapor in an atmosphere of inhibited red fuming nitric acid. Solenoid operated shut-off valve is leakproof and operates at a maximum of 1 amp. and 28 volts d.c. Contacts are gold plated; cover, packing and lubricant are selected with consideration of the environment and fluids to be contacted.

Randall Engineering Corp., 5933 Bowcroft St., Los Angeles, Calif.

Integrated Sequence Control

Sequence control is designed to perform hydraulic, pneumatic and electrical sequencing of safety override functions involved in the operation of missile engines.

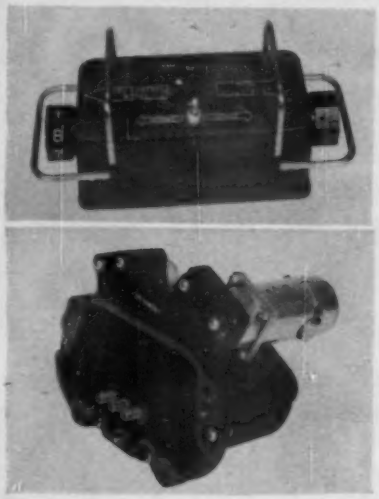
Employed in this control is a malfunction actuator, timers, combination pneumatic and fuel sequencing valves, electric sequencer switches, and a pneumatic actuator. Control is a single unit and can be located on missile engines.

Bendix Products Division, South Bend, Ind.

Jet Engine Trimmer

Jet engine fuel trimmer system permits one man in cockpit of aircraft to adjust jet engine fuel controls. Job formerly required two or three men.

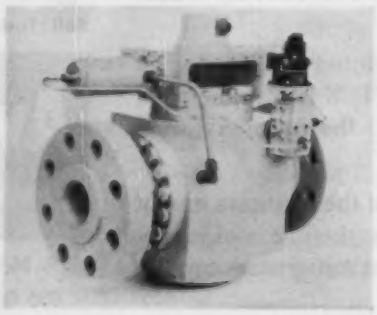
System utilizes servo actuators clamped to engine fuel controls and operated by man in cockpit who is able to monitor engine instruments. Trimmer was designed for Pratt & Whitney J57 and J75 engines. Cost of unit is approximately $1,500.



Lear, Inc., Grand Rapids, Mich.

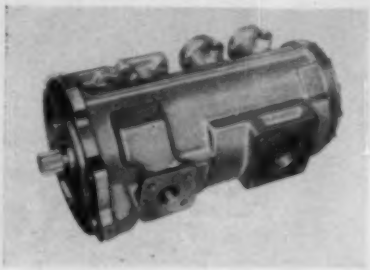
Ball Valve for Fluids

Pressure operated ball type valve is said to be capable of fully opening or closing a 3 in. line in 7 milliseconds, working against liquid or gas pressure up to 4,000 psi at temperatures up to 250F. Applications suggested include missile fueling systems, aircraft catapult launchers and fire extinguisher systems.



Valve utilizes a high pressure air accumulator controlled by an integral explosive squib pilot valve. Low amperage current sets off the squib, releasing the air to a cylinder piston which rotates the valve. Built-in, motor operated, 4-way selector valve permits recharging of the accumulator and recycling of the actuating cylinder.

Hydromatics, Inc., 70 Okner Parkway, Livingston, N. J.



Lube and Scavenge Pump

Pump, designed for nuclear type engines, has four lube elements, three scavenge elements and can pump 72 gpm. at 75 psi. with MIL-L-7808C oil at 350F, the maker states.

Model P-934 pump has a ductile iron housing and meehanite gear component housings, permitting operation in temperature range from −65 to + 1000F. Rotating face seal prevents leakage between the lube and scavenge sections and each lube element has a discharge check valve to prevent leakage greater than 1,200 cc. in 72 hr., manufacturer says.

Lear-Romec Division, Lear, Inc., Elyria, Ohio.

Adjustable Handling Unit

Mobile multi-fixture is designed to accommodate a variety of component parts of air frames, jet engines and missiles. Unit fits all sizes, shapes and weights for which special fixtures had

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. . . TECHNICIANS

FIELD ASSIGNMENTS
HOME and ABROAD

with

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located in Suburban
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Expanding activities on our prime ballistic missile contracts —**REDSTONE** and **JUPITER**— require the addition of experienced technical personnel for our Field Engineering Section at both domestic and overseas locations.

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- **INSTALLATION ENGINEERS**
- **ENGINEERING INSTRUCTORS**
- **MAINTENANCE ENGINEERS**
- **MANUAL COORDINATORS**

Current openings include **management** positions on the Field Engineering Staff in Detroit and at various field locations.

To qualify, applicants must possess at least 2 years technical schooling, a solid engineering background in missiles, aircraft, electronics, military equipment or related missile field engineering activities and strictly mobile for job assignments.

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For further information submit a complete resume of your qualifications in confidence to:

Mr. J. A. Murray
Technical Recruitment Supervisor
CHRYSLER CORPORATION
Missile Division
P. O. Box 2628
Detroit 31, Michigan

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RATED FLIGHT ENGINEERS FOR CONSTELLATION AIRCRAFT

MUST HAVE COMMERCIAL LICENSE AND INSTRUMENT RATING:

P-8443 Aviation Week
520 N. Michigan Ave., Chicago 11, Ill.

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AERONAUTICAL ENGINEERING

Univ. of Southern California. Aviation Safety Program. Require B.S. in A.E., flying experience and acquaintance with power plants. Salary $9,000 for 11 month year. Opportunity provided for some study or consultation work. Send resume to Aviation Safety Division, U.S.C. Los Angeles 7, California

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If you have been looking for an Employment Agency that is skilled in the **STATE OF THE ART** of Technical Recruitment and **RELIABILITY OF INFORMATION** concerning positions, why not communicate with us at once! ALL POSITIONS FEE PAID.

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1218 Chestnut St. Phila. 7, Pa.
Specialists in Aviation, Electronics and Nucleonics

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Permanent positions with Sandia Corporation, engaged in the ordnance phases of nuclear weapons research and development for the AEC. We have openings for engineers at all degree levels who have 2 to 6 years experience.

STRUCTURES: Experience in analysis of systems or structures for optimum load paths, methods of analysis, and most efficient and practical structure design consistent with applicable specifications and environment.

DYNAMICS: Experience in analysis of systems or structures subjected to shock and/or vibratory loads. The evaluation of structures will often require use of differential equations and a knowledge of static and dynamic properties of various metals.

•

Sandia Corporation, located in Albuquerque, N. M., offers excellent working and living conditions and generous employee benefits, including liberal holidays and vacations, retirement and insurance plans, and graduate educational aid program.

•

Write to Staff Employment
Section 592

SANDIA CORPORATION
ALBUQUERQUE, NEW MEXICO

ENGINEERS & SCIENTISTS

Join In The Development Of A New Regime Of Power Plants At

FLIGHT PROPULSION LABORATORY

OF

GENERAL ELECTRIC

FLIGHT PROPULSION LABORATORY,
CINCINNATI 15, OHIO

GROUPS of engineers and scientists at this laboratory are working on very advanced jet and rocket engines and new approaches to space propulsion.

A number of new openings have developed on technological projects bearing on the high altitude performance of specific power plants.

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- *APPLICATIONS SPECIALISTS*
- *FACILITIES PROJECT ENGINEERS*
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- *SPECIAL OPENINGS . . . for engineers to help solve engineering problems in regard to mass production with the production engineering department.*

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Bldg. 100 Dept. 58 WD

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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Subject to Agency Commission.

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Position Wanted Ads are ½ of above rate.

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Discount of 10% if full payment is made in advance for 4 consecutive insertions.

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Write us for complete details. We'll send you literature and we'll tell you about the advantages of family living in Cincinnati—"Queen City of the West, Closest to the Heart of America". There are numerous company benefits and you will be paid generous relocation expenses.

Send your resume to: **FRANK PLASHA, PERSONNEL MANAGER, DIVISION HEADQUARTERS DEPT. 30**

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CROSLEY DIVISION
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SCIENTISTS

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advanced missile and space vehicle engineering

A few high-level opportunities with Missile & Ordnance Systems Dept. of General Electric

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Design and develop systems for communication through ionized media and infrared. Working with small study group on coding, multi-path, and associated propagation problems.

PHYSICIST . . . AEROSCIENCE LABORATORY

MS degree plus 5 to 8 years' experience.

Investigate solid state phenomena and shock hydro-dynamics associated with development of structures for hypersonic vehicles.

AERONAUTICS SPECIALIST

PhD in Aeronautics Engineering preferred; 6 to 10 years' experience in high-temperature heat transfer and shock wave studies.

Conduct experimental investigations of shock-wave and heat-transfer phenomena with extremely advanced installations at Aeroscience Laboratory.

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BS, MS, PhD in EE, plus 3 to 10 years' experience covering advanced circuitry, telemetry and infrared applications.

Develop theory and analyze operation requirements for missile communications; design and develop systems.

●

The major technical programs at MOSD are carried on under long term prime development contracts. The climate here is one of scientific curiosity pursued under ideal laboratory conditions.

Please send your resume to:
Mr. Richard Eddy,
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MISSILE & ORDNANCE SYSTEMS DEPARTMENT
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PROPOSALS, $2.70 a line an insertion.

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Immediate Delivery

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R985 **R1340** **R2000**

and our most popular DC3 engine

R1830 - SUPER - 92

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P&W 1830-94—Low Time

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CAA Four-place Commercial Licensed with fresh complete overhaul. Six left, with spares. Can be purchased individually "AS IS" if desired.

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680 Aero Demo used only since April, 1958: $94,000.

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SUPER D18S—SPEED KIT
SACRIFICE FOR QUICK SALE
MADDEN & PLAYFORD AIRCRAFT
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Linden Airport Linden, N. J.

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Technical Analysis of Nuclear Power Plants for

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Minimum Salary $14,000 or More (dependent upon experience)

A new complex of technical problems is encountered in weapons system analysis of nuclear propulsion systems for flight.

The engineer who can head up Technical Analysis at General Electric's Aircraft Nuclear Propulsion Dept. must initiate pioneer studies and develop new technological criteria. He will direct a continuing program to keep engineering management informed of development trends in this advanced field.

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Write in confidence to: Mr. P. W. Christos

AIRCRAFT NUCLEAR PROPULSION DEPT.

GENERAL ELECTRIC

Div. 58-WD, P.O. Box 132, Cincinnati 15, Ohio

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SAN FRANCISCO 4: 68 Post St.

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Helicopter Mechanics—With experience on bell helicopters. Both domestic and foreign assignments. Helicopter Surveys, Inc., P. O. Box 186, Sta. B., Bakersfield, Calif.

Southern California Beechcraft distributor looking for A & E mechanics. Reply P-8363, Aviation Week.

Aeronautical Engineer—Graduate, experienced in CAA structural requirements, 3 to 5 years experience in aircraft industry. Will work on exciting new executive aircraft, the Helio Courier. Small town, adequate housing and schools. Address inquiries to Mid-States Mfg. Div., Helio Aircraft Corp., P. O. Box 604, Pittsburg, Kansas.

POSITIONS WANTED

Contract Administration, 2 years experience USAF contracting officer, knowledge Gov't. procurement procedures. B.A. Economics, Age 25, Single. Desire Career opportunities. Will relocate. PW-8421, Aviation Week.

ATR Pilot. Age 37. Air Force, Airline and eight years Chief Pilot Executive operation. DC3 and Twin-Beech 8700 Hours. Resume on request. PW-8147, Aviation Week.

Assistant to President. Engineering degree with graduate work in human relations. Experienced in staff work requiring organization and coordination. Ability and initiative are important requirements of the job I seek. PW-8547, Aviation Week.

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Ex-military pilot, 35, family. Commercial, ASMEL, Instrument, Flight instructor, will locate anywhere, recent flight and business experience, desires corporation, multi-or single. PW-8521, Aviation Week.

POSITIONS WANTED

Businessman—Pilot seeks opportunity to promote and sell business aircraft at manufacturer or distributor level. 17 years continuous aviation experience SMEL and Inst. Knowledge jet operations. 12 years sales experience. Presently operating own brokerage business. Resume and photo on request. PW-8517, Aviation Week.

Desire position as company or airline co-pilot abroad. 2000 hrs. USAF & airline, 28, BA degree plus 1 yr. language study France. Resume on request. PW-8493 Aviation Week.

Naval Aviator, 1300 hrs diversified flying. Comm. SMEL Inst. Age 26, Family. Desires position with future, utilizing talents in aviation. 1003 E. Hutchinson St. Beeville, Texas.

WANTED

PURCHASING AGENT EXPERIENCE—

Aircraft parts—airline experience desirable, but not mandatory—forward resume stating salary requirements—

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PILOTS WANTED

Must have commercial S&MEL Instrument and A&E license with a minimum flying time of approximately 1250 to 2000 hours.

Contact Personnel Department
GULF STATES UTILITIES COMPANY
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THIS EMPLOYMENT OPPORTUNITIES SECTION offers a quick, effective solution to your manpower problems. Because its readership is confined to just the type of men you need, waste circulation is avoided.

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T-Category Kit Installed

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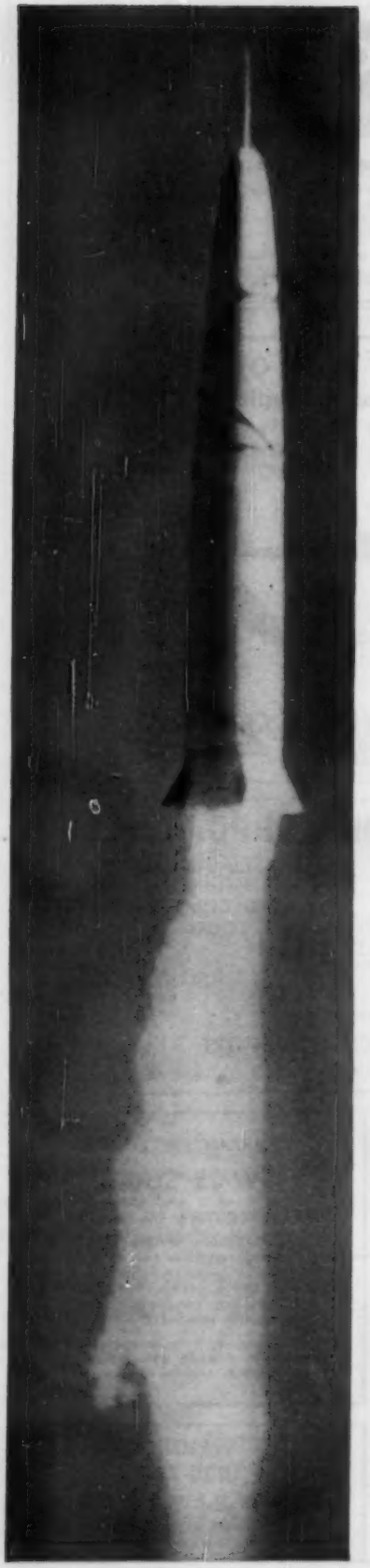

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LETTERS

Polar Orbits

In your March 17 issue, p. 21, there is envisioned the placing of scientific satellites in polar orbits using rocket accelerators launched from Pt. Mugu, Calif. It is true that Cape Canaveral, Fla., serves as a surface launching point from which to establish orbits lying in or near the plane of the ecliptic, and that Russia possesses a launching point suitable for orbits lying in or near a plane perpendicular to that of the ecliptic; but it does not necessarily follow that Pt. Mugu ought to be considered suitable seriously for polar orbits. Opposing the eastward rotation of the earth, Pt. Mugu possesses the same intrinsic geodynamic disadvantages for satellite launchings as does that of Woomera, South Australia.[1]

The ideal universally suitable launching point would be where the earth's axis of rotation passes through the lithospheric surface, namely, on the Antarctic continent; but a more practical and immediately accessible location is available at Port Pegasus on Stewart Island in New Zealand. The range aspect could be along the meridian between Campbell and Auckland Islands, southwardly over the Belleny, Coulman, Franklin and Ross Islands.

What better gesture could the United States render the advancement of science than to launch a series of scientifically valuable satellites[2] from Stewart Island—by arrangement with New Zealand[3]—using rockets such as the Titan, Vanguard, Atlas and Jupiter: it being desirable that IGY activities be prolonged into the 1960's in first instances[4] and because the choice of orbits from such a point is almost unlimited.

Since prospects for the writer in the design and control of liquefied-gaseous-fuel space rockets are not present in Australia, he seeks wholeheartedly to continue in North America and invites offers to do so.

William H. Finlay
Linton House
Kirribilli, Sydney, N. S. W.
Australia

1 Finlay, W. H., "Launching IGY Satellites", 1958, Proc. I.R.E., Jan., p. 357
2 Allen, J. A. Van, "Scientific Uses of Earth Satellites", 1956, Mich., pp. 177/8-316
3 Robertson, E. I., "Science in New Zealand", 1957, Wellington, pp. 36-45
4 Presidential press announcement on Antarctica, 1958, May 4, Washington, D. C.

Group Air Travel

I read with considerable interest the article "Transatlantic Charter Growth Foreseen" (AW June 2, p. 28). It would appear that this type of operation can have a very important long range benefit to commercial aviation, since group travel at bargain rates will not only tap a new segment of the market but also tend to develop travel tastes among income groups which would not normally supply transatlantic travelers.

To convert the group traveler into a repeat customer, and thus a potential client for the scheduled airlines, his first experience in long-range travel should, of course, be reasonably satisfactory. If the service provided on such flights—and I am not referring to the amount of bread showing on their sandwiches—is poor, the customer is not too likely to repeat the experiment, either by charter or scheduled flight, and that would be deplorable since it seems there are going to be an awful lot of seats to fill when the new jets go into service.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The following is an example of how group travel should not be handled, not even at bargain rates. The story is true, but the names have been changed to protect the culprits.

John Smith works for a large company with a very good industrial relations department. Some three months ago he learned that an industrial group, of which his company is a member was organizing a tour of Europe. This sounds interesting, particularly since this "Millionaire's Vacation" will last 16 days and transatlantic transportation will be provided by a first class aircraft chartered from a well-known scheduled carrier.

John Smith counts his change, signs up and relaxes in joyful anticipation.

One month before departure date John Smith is requested to pay. Then he learns that some minor changes have been made. Nothing important, really. They are not going to fly with the airline that was originally contemplated, but with a very reliable non-scheduled outfit. The first class accommodations are provided by a giant DC-6A, seating some 90-odd passengers. And they are going to leave a day later than intended, Sunday instead of Saturday, thus providing John with a full free day to do his shopping. Our friend recalls dimly that the DC-6A was originally a cargo plane and the seating appears a little crowded, but then after all he is getting a terrific bargain.

As time goes on he learns that the plane will not leave until Sunday evening, and will take some 17 hours to get from New England to Frankfurt; that is, he has lost another day of his precious vacation time. Ten days before departure he is informed that the flight has not been approved by the CAA and may be cancelled. The travel agency arranging the flight, the industrial group director, and several other people knew about this difficulty for some two weeks before they let John in on their little secret. For two days our friend is in agony—his plans have been shattered and it is too late to make other arrangements.

When John Smith finally learns that the CAA has relented he is naturally relieved, but he still keeps wondering if he should have signed up at all. Perhaps the airline is not as reliable as he was told. If this is his first major trip, as it probably is, he may also get a little frightened. Are all parties really acting in good faith? He has the feeling, moreover, that no one really cares if he has enough time in Europe; that he is merely a statistical figure or perhaps an insignificant carrier of profit in the hands of the airline, travel agency, and industrial group. By now he has voiced some complaints, in his company, to the industrial group, and has been patiently given to understand that everyone is doing whatever can be done, that he does not understand what is going on and why must he pester hardworking people.

The final crisis does not occur until D-day minus two when John Smith is awakened at 11:30 p.m. and receives a telegram. Yes, you guessed it. The flight is delayed and will now leave on Monday, shortly before noon. In agony he gets a calendar, he counts on his fingers; no good, another expensive day is gone down the drain.

By now our friend has had quite enough. He decides to go it alone by scheduled flight, and damn the expense. His wife and dog are waked up, coffee is fixed, and then they settle down to some hard work. Two hours later they have a beautiful plan. They will postpone their vacation by one week, fly over, and have 16 glorious days in Europe.

The only problem remaining is the cancellation of their ill-fated tour. John Smith calls up the industrial group and wants his money back. No dice. He explains in full detail why the trip he would be getting bears only a slight resemblance to the trip he thought he bought. Sorry, the industrial group has paid the money to the agency and he cannot get it back. Period. Our friend mutters about parties acting in bad faith, breach of contract, and some words we shall not repeat here. It seems the contract between the industrial group and the travel agency is ironclad.

Alas, John Smith has no choice but to go along and try to get his money's worth, feeling very strongly that he has been had. On that trip it won't take much to cure Mr. Smith quite permanently from any inclination towards future trips to Europe. After all, buying a new car is much simpler and involves, also, considerably less risk.

The question seems to be this: how many Mr. Smiths can our air carriers, scheduled or non-scheduled, afford to produce over the next few years?

Rolf Wild
Hamden, Conn.

Formation Landings

Re: "Italian Team Pioneers in Formation Landings" (AW May 19, p. 81) and the letter from Lt. Mark Perrault, USN, PIO, Blue Angels (AW June 30, p. 86).

What the hell! Has everybody forgotten those pictures of 1928—to about 1932—of three single place Army fighters tied together from takeoff to landing, in aerobatic demonstrations.

Wasn't Carl Spaatz one of the pilots? Were they Boeing P-12's?

Anyhow, if you tie three of 'em together and they land thataway—ain't that *formation* landing?

Bob Arentz
Transport Indemnity Co.
Denver, Colo.

LONG-LOK INSERTS: a positive solution to fastening problems that...

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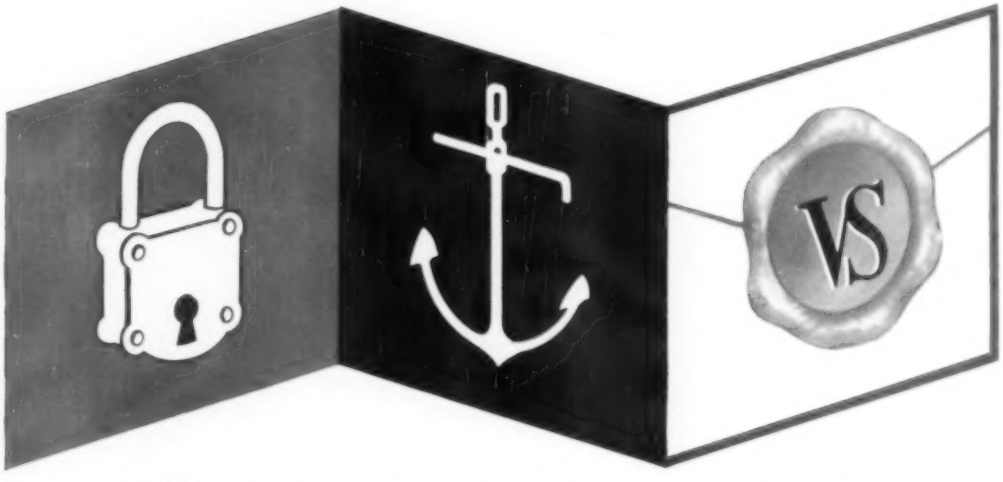

VOI-SHAN offers a new, proof-tested solution to fastener locking problems — the LONG-LOK insert. Particularly suited to tapped-hole uses, this prevailing-torque-type locking feature installs into any male-threaded part, or automatically anchors screw-thread adjustment device controls. While available in a spectrum of insert materials designed for various operating conditions, the LONG-LOK insert can be processed to act as a dam to fluid or gas leakage along the thread helix. Qualified to performance requirements of applicable military specifications, LONG-LOK replaces lockwashers, lockwires, and liquid staking compounds. Write for free literature and further information on LONG-LOK for your specific application requirements.

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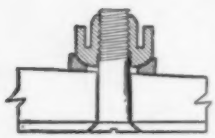
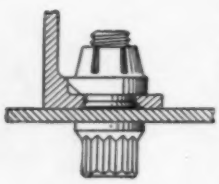
ESNA gang channel nut strips eliminate the costly, time consuming installation job of riveting individual nuts. Available in straight or curved sections and even complete rings, custom designed for applications such as access doors or inspection covers.



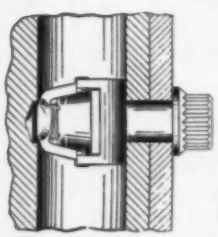
Bolting non-parallel surfaces

No more costly spot facing, step milling or hand selecting tapered shims! ESNA's counterbored, self-aligning types include one lug, two lug, gang channel, standard hex and high tensile types. Ball-and-socket relationship of nut and special base allow an 8° tilt in any direction from centerline to compensate for draft angle or tapered sections.



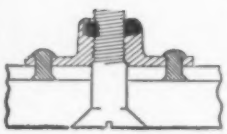
Fastening stressed joints subject to temperatures up to 1300°F.

For really "hot" applications such as jet engine flange assemblies or fire wall sections, where fastener dependability is critical, ESNA offers the "long-beam" locking device. The full cantilever of these sections assures protection against failures related to relaxation, creep and similar problems caused by the effects of extremely high temperatures upon metals. **(Ask for ESNA Bulletin No. 5715 Design Manual for High Temperature Self-Locking Nuts.)**



Simplifying major substructure joining

An ESNA barrel nut doesn't have to be held for wrenching . . doesn't need precisely mated bolt holes. The barrel-shaped fastener, is simply finger-pressed into a drilled or reamed hole until the special clip snaps into position at the bolt hole location. The .030" float of the nut section of this fitting avoids misalignment problems and the bathtub recess for wrenching area is eliminated. New NAS 577 barrel nut (180,000 psi) now available. Also 160,000 and new 220,000 psi series.



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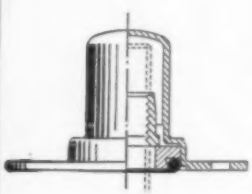
Attaching components in areas with limited wrench clearance.

Miniaturized insert-type hex nuts with across-the-flats dimensions as small as .109 in the 0-80 size . . . or all metal (550°F.) nuts to AN365 or NAS 679 performance specifications with internal wrenching hexagon faces (which permit use of smaller wrench sizes) are available for use at locations where space and weight limitations are paramount. Complete lines of NAS miniature anchor nuts in carbon steel and A286 stainless steel are also in production. **Ask for your copy of the NAS/ESNA Conversion Book.**



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